Nexus® 1250/1252

Power Meter and Power Quality Recorder

Installation & Operation Manual

V.1.35

January 9, 2013

Electro Industries/GaugeTech

The Leader In Power Monitoring and Smart Grid Solutions

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Nexus® 1252 Meter Installation and Operation Manual Version 1.35

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Customer Service and Support

Customer support is available 9:00 am to 4:30 pm, Eastern Standard Time, Monday through Friday. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have all meter readings available. When returning any merchandise to EIG, a return materials authorization number is required. For customer or technical assistance, repair or calibration, phone 516-334-0870 or fax 516-338-4741.

Product Warranty

Electro Industries/GaugeTech warrants all products to be free from defects in material and workmanship for a period of four years from the date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, fax or call our customer-support department. You will receive prompt assistance and return instructions. Send the instrument, transportation prepaid, to EIG at 1800 Shames Drive, Westbury, NY 11590. Repairs will be made and the instrument will be returned.

This warranty does not apply to defects resulting from unauthorized modification, misuse, or use for any reason other than electrical power monitoring. The Nexus® 1252 meter is not a user-serviceable product.

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Our products are not to be used for primary over-current protection. Any protection feature in our products is to be used for alarm or secondary protection only.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by Electro Industries/GaugeTech. The accuracy and a calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards. For optimal performance, EIG recommends that any meter, including those manufactured by EIG, be verified for accuracy on a yearly interval using NIST traceable accuracy standards.

Disclaimer

The information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.

Safety Symbols

In this manual, this symbol indicates that the operator must refer to an important WARNING or CAUTION in the operating instructions. Please see Chapter 4 for important safety information regarding installation and hookup of the meter.

The following safety symbols may be used on the meter itself:

This symbol alerts you to the presence of high voltage, which can cause dangerous electrical shock.

This symbol indicates the field wiring terminal that must be connected to earth ground before operating the meter, which protects against electrical shock in case of a fault condition.

About Electro Industries/GaugeTech (EIG)

Founded in 1975 by engineer and inventor Dr. Samuel Kagan, Electro Industries/GaugeTech changed the face of power monitoring forever with its first breakthrough innovation: an affordable, easy-to-use AC power meter.

Thirty years since its founding, Electro Industries/GaugeTech, the leader in power monitoring and control, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2000 certified company, EIG sets the industry standard for advanced power quality and reporting, revenue metering and substation data acquisition and control. EIG products can be found on site at mainly all of today's leading manufacturers, industrial giants and utilities.

EIG products are primarily designed, manufactured, tested and calibrated at our facility in Westbury, New York.

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1:Three-Phase Power Measurement

This introduction to three-phase power and power measurement is intended to provide only a brief overview of the subject. The professional meter engineer or meter technician should refer to more advanced documents such as the EEI Handbook for Electricity Metering and the application standards for more in-depth and technical coverage of the subject.

1.1: Three-Phase System Configurations

Three-phase power is most commonly used in situations where large amounts of power will be used because it is a more effective way to transmit the power and because it provides a smoother delivery of power to the end load. There are two commonly used connections for three-phase power, a wye connection or a delta connection. Each connection has several different manifestations in actual use.

When attempting to determine the type of connection in use, it is a good practice to follow the circuit back to the transformer that is serving the circuit. It is often not possible to conclusively determine the correct circuit connection simply by counting the wires in the service or checking voltages. Checking the transformer connection will provide conclusive evidence of the circuit connection and the relationships between the phase voltages and ground.

1.1.1: Wye Connection

The wye connection is so called because when you look at the phase relationships and the winding relationships between the phases it looks like a Y. Figure 1.1 depicts the winding relationships for a wye-connected service. In a wye service the neutral (or center point of the wye) is typically grounded. This leads to common voltages of 208/120 and 480/277 (where the first number represents the phase-to-phase voltage and the second number represents the phase-to-ground voltage).

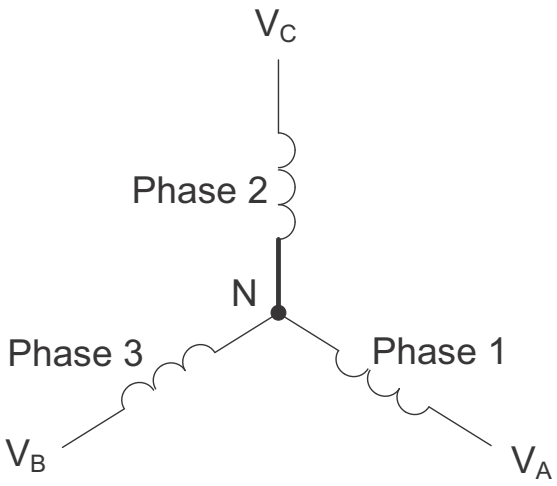

Figure 1.1: Three-phase Wye Winding

The three voltages are separated by 120° electrically. Under balanced load conditions the currents are also separated by 120°. However, unbalanced loads and other conditions can cause the currents to depart from the ideal 120° separation. Three-phase voltages and currents are usually represented with a phasor diagram. A phasor diagram for the typical connected voltages and currents is shown in Figure 1.2.

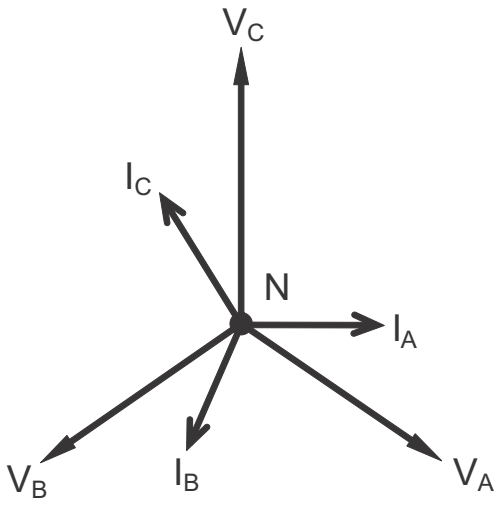

Figure 1.2: Phasor Diagram Showing Three-phase Voltages and Currents

The phasor diagram shows the 120^{o} angular separation between the phase voltages. The phase-to-phase voltage in a balanced three-phase wye system is 1.732 times the phase-to-neutral voltage. The center point of the wye is tied together and is typically grounded. Table 1.1 shows the common voltages used in the United States for wye-connected systems.

Phase to Ground Voltage	Phase to Phase Voltage
120 volts	208 volts
277 volts	480 volts
2,400 volts	4,160 volts
7,200 volts	12,470 volts
7,620 volts	13,200 volts

Table 1: Common Phase Voltages on Wye Services

Usually a wye-connected service will have four wires: three wires for the phases and one for the neutral. The three-phase wires connect to the three phases (as shown in Figure 1.1). The neutral wire is typically tied to the ground or center point of the wye.

In many industrial applications the facility will be fed with a four-wire wye service but only three wires will be run to individual loads. The load is then often referred to as a delta-connected load but the service to the facility is still a wye service; it contains four wires if you trace the circuit back to its source (usually a transformer). In this type of connection the phase to ground voltage will be the phase-to-ground voltage indicated in Table 1, even though a neutral or ground wire is not physically present at the load. The transformer is the best place to determine the circuit connection type because this is a location where the voltage reference to ground can be conclusively identified.

1.1.2: Delta Connection

Delta-connected services may be fed with either three wires or four wires. In a three-phase delta service the load windings are connected from phase-to-phase rather than from phase-to-ground. Figure 1.3 shows the physical load connections for a delta service.

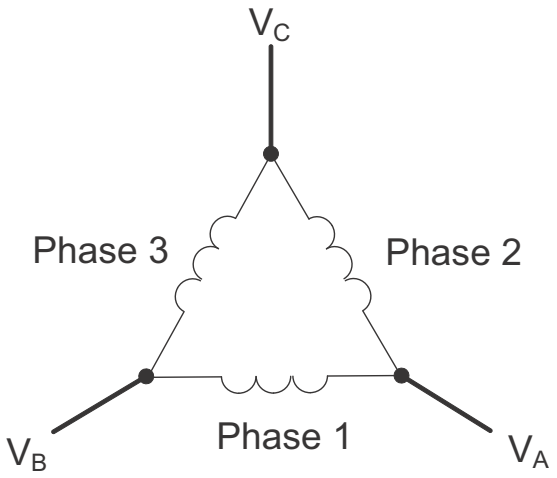

Figure 1.3: Three-phase Delta Winding Relationship

In this example of a delta service, three wires will transmit the power to the load. In a true delta service, the phase-to-ground voltage will usually not be balanced because the ground is not at the center of the delta.

Figure 1.4 shows the phasor relationships between voltage and current on a three-phase delta circuit.

In many delta services, one corner of the delta is grounded. This means the phase to ground voltage will be zero for one phase and will be full phase-to-phase voltage for the other two phases. This is done for protective purposes.

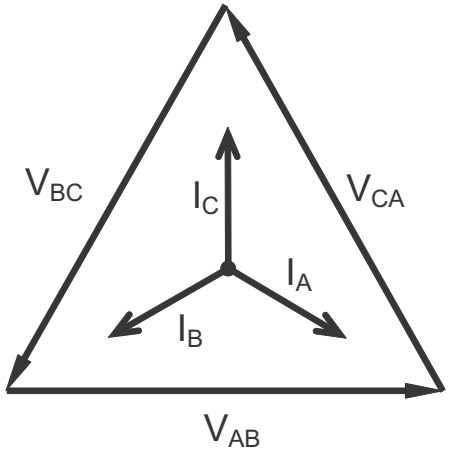

Figure 1.4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

Another common delta connection is the four-wire, grounded delta used for lighting loads. In this connection the center point of one winding is grounded. On a 120/240 volt, four-wire, grounded delta service the phase-to-ground voltage would be 120 volts on two phases and 208 volts on the third phase. Figure 1.5 shows the phasor diagram for the voltages in a three-phase, four-wire delta system.

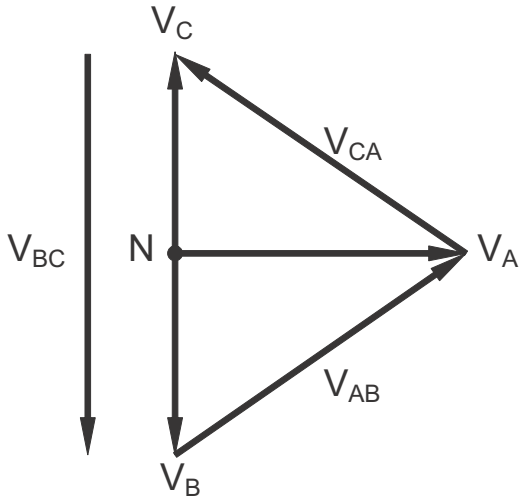

Figure 1.5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

1.1.3: Blondell's Theorem and Three Phase Measurement

In 1893 an engineer and mathematician named Andre E. Blondell set forth the first scientific basis for polyphase metering. His theorem states:

If energy is supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of the readings of N wattmeters so arranged that each of the N wires contains one current coil, the corresponding potential coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 Wattmeters.

The theorem may be stated more simply, in modern language:

In a system of N conductors, N-1 meter elements will measure the power or energy taken provided that all the potential coils have a common tie to the conductor in which there is no current coil.

Three-phase power measurement is accomplished by measuring the three individual phases and adding them together to obtain the total three phase value. In older analog meters, this measurement was accomplished using up to three separate elements. Each element combined the single-phase voltage and current to produce a torque on the meter disk. All three elements were arranged around the disk so that the disk was subjected to the combined torque of the three elements. As a result the disk would turn at a higher speed and register power supplied by each of the three wires.

According to Blondell's Theorem, it was possible to reduce the number of elements under certain conditions. For example, a three-phase, three-wire delta system could be correctly measured with two elements (two potential coils and two current coils) if the potential coils were connected between the three phases with one phase in common.

In a three-phase, four-wire wye system it is necessary to use three elements. Three voltage coils are connected between the three phases and the common neutral conductor. A current coil is required in each of the three phases.

In modern digital meters, Blondell's Theorem is still applied to obtain proper metering. The difference in modern meters is that the digital meter measures each

phase voltage and current and calculates the single-phase power for each phase. The meter then sums the three phase powers to a single three-phase reading.

Some digital meters calculate the individual phase power values one phase at a time. This means the meter samples the voltage and current on one phase and calculates a power value. Then it samples the second phase and calculates the power for the second phase. Finally, it samples the third phase and calculates that phase power. After sampling all three phases, the meter combines the three readings to create the equivalent three-phase power value. Using mathematical averaging techniques, this method can derive a quite accurate measurement of three-phase power.

More advanced meters actually sample all three phases of voltage and current simultaneously and calculate the individual phase and three-phase power values. The advantage of simultaneous sampling is the reduction of error introduced due to the difference in time when the samples were taken.

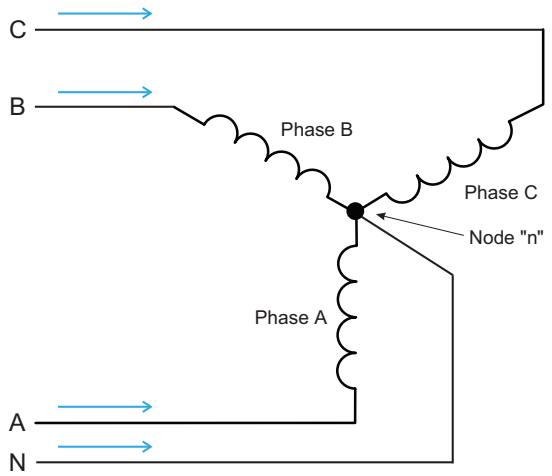

Figure 1.6: Three-Phase Wye Load Illustrating Kirchhoff's Law and Blondell's Theorem

Blondell's Theorem is a derivation that results from Kirchhoff's Law. Kirchhoff's Law states that the sum of the currents into a node is zero. Another way of stating the same thing is that the current into a node (connection point) must equal the current out of the node. The law can be applied to measuring three-phase loads. Figure 1.6 shows a typical connection of a three-phase load applied to a three-phase, four-wire service. Krichhoff's Law holds that the sum of currents A, B, C and N must equal zero or that the sum of currents into Node "n" must equal zero.

If we measure the currents in wires A, B and C, we then know the current in wire N by Kirchhoff's Law and it is not necessary to measure it. This fact leads us to the conclusion of Blondell's Theorem- that we only need to measure the power in three of the four wires if they are connected by a common node. In the circuit of Figure 1.6 we must measure the power flow in three wires. This will require three voltage coils and three current coils (a three-element meter). Similar figures and conclusions could be reached for other circuit configurations involving Delta-connected loads.

1.2: Power, Energy and Demand

It is quite common to exchange power, energy and demand without differentiating between the three. Because this practice can lead to confusion, the differences between these three measurements will be discussed.

Power is an instantaneous reading. The power reading provided by a meter is the present flow of watts. Power is measured immediately just like current. In many digital meters, the power value is actually measured and calculated over a one second interval because it takes some amount of time to calculate the RMS values of voltage and current. But this time interval is kept small to preserve the instantaneous nature of power.

Energy is always based on some time increment; it is the integration of power over a defined time increment. Energy is an important value because almost all electric bills are based, in part, on the amount of energy used.

Typically, electrical energy is measured in units of kilowatt-hours (kWh). A kilowatt-hour represents a constant load of one thousand watts (one kilowatt) for one hour. Stated another way, if the power delivered (instantaneous watts) is measured as 1,000 watts and the load was served for a one hour time interval then the load would have absorbed one kilowatt-hour of energy. A different load may have a constant power requirement of 4,000 watts. If the load were served for one hour it would absorb four kWh. If the load were served for 15 minutes it would absorb ¼ of that total or one kWh.

Figure 1.7 shows a graph of power and the resulting energy that would be transmitted as a result of the illustrated power values. For this illustration, it is assumed that the power level is held constant for each minute when a measurement is taken. Each bar

in the graph will represent the power load for the one-minute increment of time. In real life the power value moves almost constantly.

The data from Figure 1.7 is reproduced in Table 2 to illustrate the calculation of energy. Since the time increment of the measurement is one minute and since we specified that the load is constant over that minute, we can convert the power reading to an equivalent consumed energy reading by multiplying the power reading times 1/60 (converting the time base from minutes to hours).

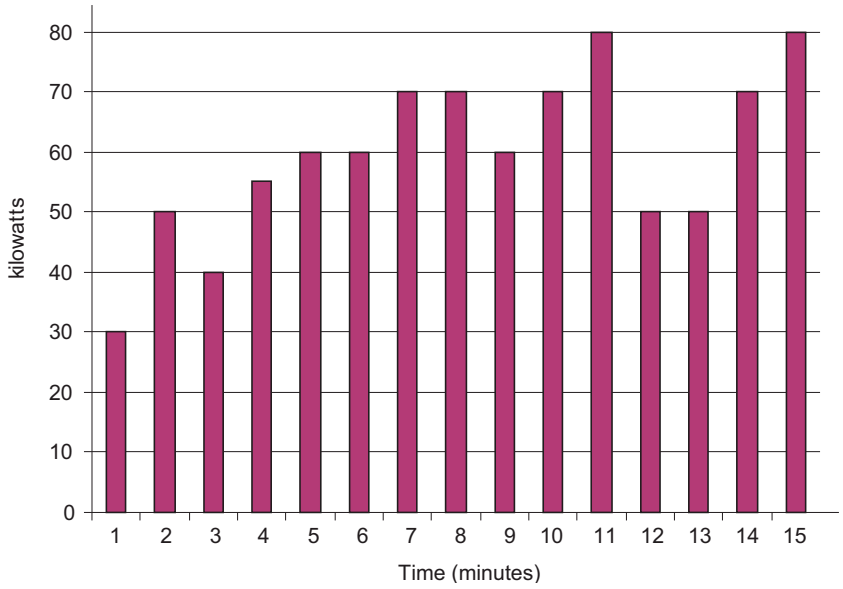

Figure 1.7: Power Use over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
1	30	0.50	0.50
2	50	0.83	1.33
3	40	0.67	2.00
4	55	0.92	2.92
5	60	1.00	3.92
6	60	1.00	4.92
7	70	1.17	6.09
8	70	1.17	7.26
9	60	1.00	8.26
10	70	1.17	9.43
11	80	1.33	10.76
12	50	0.83	12.42
13	50	0.83	12.42
14	70	1.17	13.59
15	80	1.33	14.92

Table 1.2: Power and Energy Relationship over Time

As in Table 1.2, the accumulated energy for the power load profile of Figure 1.7 is 14.92 kWh.

Demand is also a time-based value. The demand is the average rate of energy use over time. The actual label for demand is kilowatt-hours/hour but this is normally reduced to kilowatts. This makes it easy to confuse demand with power, but demand is not an instantaneous value. To calculate demand it is necessary to accumulate the energy readings (as illustrated in Figure 1.7) and adjust the energy reading to an hourly value that constitutes the demand.

In the example, the accumulated energy is 14.92 kWh. But this measurement was made over a 15-minute interval. To convert the reading to a demand value, it must be normalized to a 60-minute interval. If the pattern were repeated for an additional three 15-minute intervals the total energy would be four times the measured value or

59.68 kWh. The same process is applied to calculate the 15-minute demand value. The demand value associated with the example load is 59.68 kWh/hr or 59.68 kWd. Note that the peak instantaneous value of power is 80 kW, significantly more than the demand value.

Figure 1.8 shows another example of energy and demand. In this case, each bar represents the energy consumed in a 15-minute interval. The energy use in each interval typically falls between 50 and 70 kWh. However, during two intervals the energy rises sharply and peaks at 100 kWh in interval number 7. This peak of usage will result in setting a high demand reading. For each interval shown the demand value would be four times the indicated energy reading. So interval 1 would have an associated demand of 240 kWh/hr. Interval 7 will have a demand value of 400 kWh/hr. In the data shown, this is the peak demand value and would be the number that would set the demand charge on the utility bill.

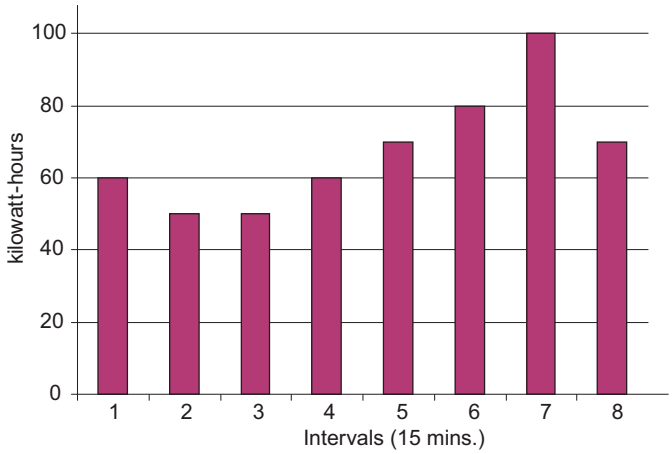

Figure 1.8: Energy Use and Demand

As can be seen from this example, it is important to recognize the relationships between power, energy and demand in order to control loads effectively or to monitor use correctly.

1.3: Reactive Energy and Power Factor

The real power and energy measurements discussed in the previous section relate to the quantities that are most used in electrical systems. But it is often not sufficient to only measure real power and energy. Reactive power is a critical component of the total power picture because almost all real-life applications have an impact on reactive power. Reactive power and power factor concepts relate to both load and generation applications. However, this discussion will be limited to analysis of reactive power and power factor as they relate to loads. To simplify the discussion, generation will not be considered.

Real power (and energy) is the component of power that is the combination of the voltage and the value of corresponding current that is directly in phase with the voltage. However, in actual practice the total current is almost never in phase with the voltage. Since the current is not in phase with the voltage, it is necessary to consider both the inphase component and the component that is at quadrature (angularly rotated 90^o or perpendicular) to the voltage. Figure 1.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

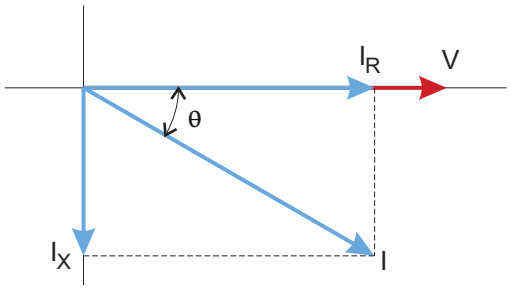

Figure 1.9: Voltage and Complex Current

The voltage (V) and the total current (I) can be combined to calculate the apparent power or VA. The voltage and the in-phase current (I_R) are combined to produce the real power or watts. The voltage and the quadrature current (I_X) are combined to calculate the reactive power.

The quadrature current may be lagging the voltage (as shown in Figure 1.9) or it may lead the voltage. When the quadrature current lags the voltage the load is requiring both real power (watts) and reactive power (VARs). When the quadrature current

leads the voltage the load is requiring real power (watts) but is delivering reactive power (VARs) back into the system; that is VARs are flowing in the opposite direction of the real power flow.

Reactive power (VARs) is required in all power systems. Any equipment that uses magnetization to operate requires VARs. Usually the magnitude of VARs is relatively low compared to the real power quantities. Utilities have an interest in maintaining VAR requirements at the customer to a low value in order to maximize the return on plant invested to deliver energy. When lines are carrying VARs, they cannot carry as many watts. So keeping the VAR content low allows a line to carry its full capacity of watts. In order to encourage customers to keep VAR requirements low, some utilities impose a penalty if the VAR content of the load rises above a specified value.

A common method of measuring reactive power requirements is power factor. Power factor can be defined in two different ways. The more common method of calculating power factor is the ratio of the real power to the apparent power. This relationship is expressed in the following formula:

Total PF = real power / apparent power = watts/VA

This formula calculates a power factor quantity known as Total Power Factor. It is called Total PF because it is based on the ratios of the power delivered. The delivered power quantities will include the impacts of any existing harmonic content. If the voltage or current includes high levels of harmonic distortion the power values will be affected. By calculating power factor from the power values, the power factor will include the impact of harmonic distortion. In many cases this is the preferred method of calculation because the entire impact of the actual voltage and current are included.

A second type of power factor is Displacement Power Factor. Displacement PF is based on the angular relationship between the voltage and current. Displacement power factor does not consider the magnitudes of voltage, current or power. It is solely based on the phase angle differences. As a result, it does not include the impact of harmonic distortion. Displacement power factor is calculated using the following equation:

$$\text{Displacement PF} = \cos\theta$$

where θ is the angle between the voltage and the current (see Fig. 1.9).

In applications where the voltage and current are not distorted, the Total Power Factor will equal the Displacement Power Factor. But if harmonic distortion is present, the two power factors will not be equal.

1.4: Harmonic Distortion

Harmonic distortion is primarily the result of high concentrations of non-linear loads. Devices such as computer power supplies, variable speed drives and fluorescent light ballasts make current demands that do not match the sinusoidal waveform of AC electricity. As a result, the current waveform feeding these loads is periodic but not sinusoidal. Figure 1.10 shows a normal, sinusoidal current waveform. This example has no distortion.

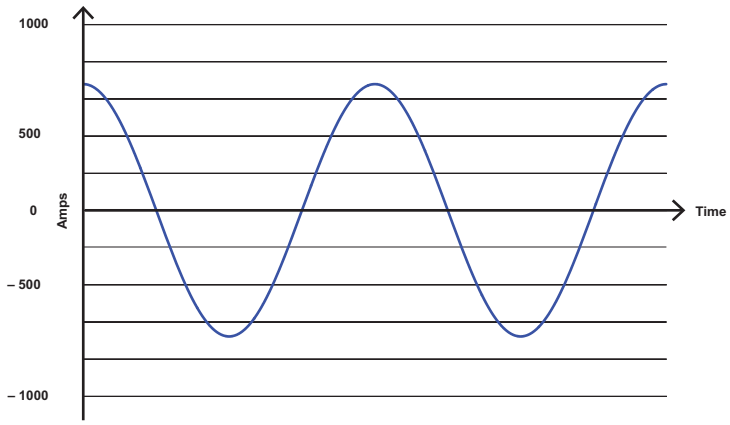

Figure 1.10: Nondistorted Current Waveform

Figure 1.11 shows a current waveform with a slight amount of harmonic distortion. The waveform is still periodic and is fluctuating at the normal 60 Hz frequency. However, the waveform is not a smooth sinusoidal form as seen in Figure 1.10.

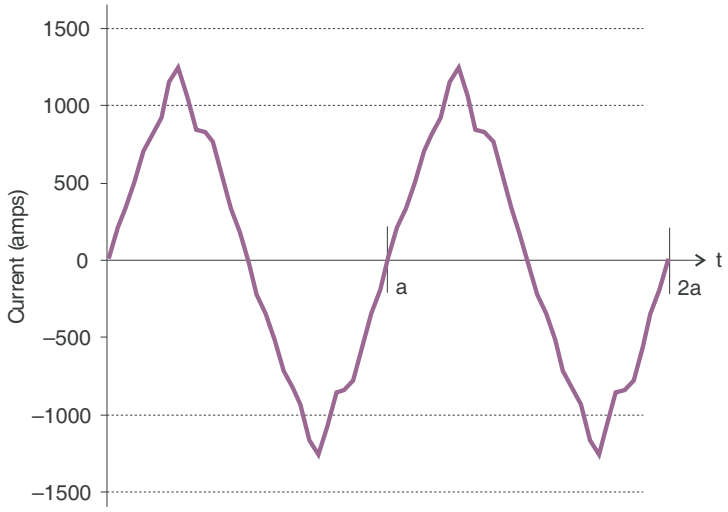

Figure 1.11: Distorted Current Waveform

The distortion observed in Figure 1.11 can be modeled as the sum of several sinusoidal waveforms of frequencies that are multiples of the fundamental 60 Hz frequency. This modeling is performed by mathematically disassembling the distorted waveform into a collection of higher frequency waveforms.

These higher frequency waveforms are referred to as harmonics. Figure 1.12 shows the content of the harmonic frequencies that make up the distortion portion of the waveform in Figure 1.11.

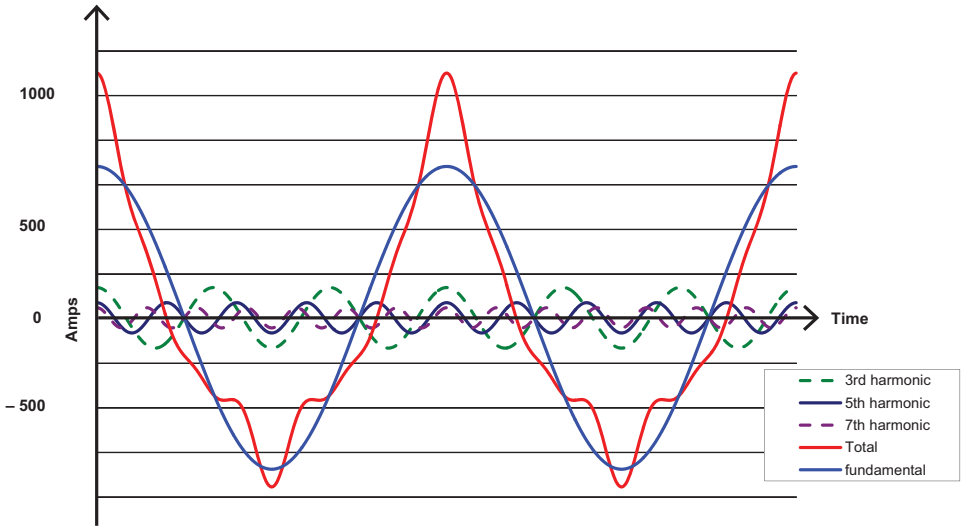

Figure 1.12: Waveforms of the Harmonics

The waveforms shown in Figure 1.12 are not smoothed but do provide an indication of the impact of combining multiple harmonic frequencies together.

When harmonics are present it is important to remember that these quantities are operating at higher frequencies. Therefore, they do not always respond in the same manner as 60 Hz values.

Inductive and capacitive impedance are present in all power systems. We are accustomed to thinking about these impedances as they perform at 60 Hz. However, these impedances are subject to frequency variation.

$$X_L = j\omega L \quad \text{and}$$

$$X_C = 1/j\omega C$$

At 60 Hz, $\omega = 377$; but at 300 Hz (5th harmonic) $\omega = 1{,}885$. As frequency changes impedance changes and system impedance characteristics that are normal at 60 Hz may behave entirely differently in the presence of higher order harmonic waveforms.

Traditionally, the most common harmonics have been the low order, odd frequencies, such as the 3rd, 5th, 7th, and 9th. However newer, new-linear loads are introducing significant quantities of higher order harmonics.

Since much voltage monitoring and almost all current monitoring is performed using instrument transformers, the higher order harmonics are often not visible. Instrument transformers are designed to pass 60 Hz quantities with high accuracy. These devices, when designed for accuracy at low frequency, do not pass high frequencies with high accuracy; at frequencies above about 1200 Hz they pass almost no information. So when instrument transformers are used, they effectively filter out higher frequency harmonic distortion making it impossible to see.

However, when monitors can be connected directly to the measured circuit (such as direct connection to a 480 volt bus) the user may often see higher order harmonic distortion. An important rule in any harmonics study is to evaluate the type of equipment and connections before drawing a conclusion. Not being able to see harmonic distortion is not the same as not having harmonic distortion.

It is common in advanced meters to perform a function commonly referred to as waveform capture. Waveform capture is the ability of a meter to capture a present

picture of the voltage or current waveform for viewing and harmonic analysis. Typically a waveform capture will be one or two cycles in duration and can be viewed as the actual waveform, as a spectral view of the harmonic content, or a tabular view showing the magnitude and phase shift of each harmonic value. Data collected with waveform capture is typically not saved to memory. Waveform capture is a real-time data collection event.

Waveform capture should not be confused with waveform recording that is used to record multiple cycles of all voltage and current waveforms in response to a transient condition.

1.5: Power Quality

Power quality can mean several different things. The terms "power quality" and "power quality problem" have been applied to all types of conditions. A simple definition of "power quality problem" is any voltage, current or frequency deviation that results in mis-operation or failure of customer equipment or systems. The causes of power quality problems vary widely and may originate in the customer equipment, in an adjacent customer facility or with the utility.

In his book Power Quality Primer, Barry Kennedy provided information on different types of power quality problems. Some of that information is summarized in Table 1.3.

Cause	Disturbance Type	Source
Impulse transient	Transient voltage disturbance, sub-cycle duration	Lightning Electrostatic discharge Load switching Capacitor switching
Oscillatory transient with decay	Transient voltage, sub-cycle duration	Line/cable switching Capacitor switching Load switching
Sag/swell	RMS voltage, multiple cycle duration	Remote system faults
Interruptions	RMS voltage, multiple seconds or longer duration	System protection Circuit breakers Fuses Maintenance
Under voltage/over voltage	RMS voltage, steady state, multiple seconds or longer duration	Motor starting Load variations Load dropping
Voltage flicker	RMS voltage, steady state, repetitive condition	Intermittent loads Motor starting Arc furnaces
Harmonic distortion	Steady state current or voltage, long-term duration	Non-linear loads System resonance

Table 1.3: Typical Power Quality Problems and Sources

It is often assumed that power quality problems originate with the utility. While it is true that may power quality problems can originate with the utility system, many problems originate with customer equipment. Customer-caused problems may manifest themselves inside the customer location or they may be transported by the utility system to another adjacent customer. Often, equipment that is sensitive to power quality problems may in fact also be the cause of the problem.

If a power quality problem is suspected, it is generally wise to consult a power quality professional for assistance in defining the cause and possible solutions to the problem.

2: Meter Overview

This chapter provides basic information on the Nexus® 1250/1252 meter.

2.1: The Nexus® System

Electro Industries' Nexus® 1250/1252 combines high-end revenue metering with sophisticated power quality analysis. Its advanced monitoring capabilities provide detailed and precise pictures of any metered point within a distribution network. The P40N+, P41N+ and P43N+ displays are detailed in Chapter 6. Extensive I/O capability is available in conjunction with all metering functions. The optional Communicator EXT software allows a user to poll and gather data from multiple Nexus® meters installed at local or remote locations (see the *Communicator EXT User Manual* for details). On board mass memory enables the meter to retrieve and store multiple logs. The Nexus® meter with Internal Modem (or Network) Option connects to a PC via standard phone line (or MODBUS/TCP) and a daisy chain of Nexus® meters via an RS485 connection. See Chapters 10 and 11 for details.

Nexus® 1250/1252 Revenue Metering

- Delivers laboratory-grade 0.04% Watt-hour accuracy (at full load Unity PF) in a field-mounted device
- Auto-calibrates when there is a temperature change of about 2 degrees Celsius
- Meets all ANSI C12.20 and IEC 62053-22 accuracy specifications
- Adjusts for transformer and line losses, using user-defined compensation factors
- Automatically logs time-of-use for up to eight programmable tariff registers
- Counts pulses and aggregates different loads

Nexus® 1250/1252 Power Quality Monitoring

- Records up to 512 samples per cycle on an event
- Records sub-cycle transients on voltage or current readings
- Measures and records Harmonics to the 255th order (Real Time Harmonics to the 128th order)

- Offers inputs for neutral-to-ground voltage measurements
- Synchronizes with IRIG-B or line frequency for clock synchronization
- Measures Flicker (1252 only)
- Offers EN50160/EN61000-4-15 logging and analysis (1252 V-2 only: see Section 2.11)

Nexus® 1250 / 1252 Memory, Communication and Control

- Up to 4 Megabytes NVRAM
- 4 high speed Communication ports
- Multiple protocols (see section below on DNP V3.00)
- Built-in RTU functionality.
- Built-in PLC functionality
- High speed updates for Control

2.2: DNP V.3.00 Level 1 and 2

NOTE: Nexus® 1250 supports DNP V3.00 Level 1; Nexus® 1252 supports DNP V3.00 Level 2.

DNP Level 2 Features:

- Up to 136 measurement (64 Binary Inputs, 8 Binary Counters, 64 Analog Inputs) can be mapped to DNP Static Points (over 3000) in the customizable DNP Point Map.
- Up to 16 Relays and 8 Resets can be controlled through DNP Level 2.
- Report-by-Exception Processing (DNP Events) Deadbands can be set on a per-point basis.
- Freeze Commands: Freeze, Freeze/No-Ack, Freeze with Time, Freeze with Time/No-Ack.

- Freeze with Time Commands enable the Nexus® meter to have internal time-driven Frozen and Frozen Event data. When the Nexus® meter receives the Time and Interval, the data is created.

For complete details, download the appropriate DNP User Manual from our website www.electroind.com.

2.3: Flicker

A Nexus® 1252 with V-1 (base configuration) provides Flicker Evaluation in Instantaneous, Short Term and Long Term Forms. A Nexus® 1252 meter with V-Switch™ key 2 provides EN50160 / EN61000-4-30 Power Quality Compliance. See Chapter 12 for a detailed explanation of the Flicker and Power Quality Compliance functions.

2.4: INP2 Internal Modem with Dial-in/Dial-out Option

The following sections describe the optional INP2 Internal Modem.

2.4.1: Hardware Overview

The INP2 Option for the Nexus® 1250/1252 meter provides a direct connection to a standard telephone line. No additional hardware is required to establish a communication connection between the meter and a remote computer. The RJ11 Jack is on the face of the meter. A standard telephone RJ11 plug can connect the meter to a standard PSTN (Public Switched Telephone Network).

The modem operates at up to 56k baud. It supports both incoming calls (from a remote computer) and automatic dial-out calls when a defined event must be automatically reported. With the device configured with the INP2 Option, the meter has dial-in capability and provides remote access to other Modbus-based serial devices via the meter's RS485 Gateway over your phone line. The meter recognizes and responds to a Modbus Address of 1. With any other address, the command passes through the gateway and become a virtual connection between the remote Modbus master and any Modbus slave connected to the RS485 Gateway.

The modem continuously monitors the telephone line to detect an incoming call. When an incoming call is detected, the modem will wait a user-set number of rings and answer the call.

2.4.2: Dial-In Function

The modem can be programmed to check for a password on an incoming call. If the correct password is not provided, the modem hangs up on the incoming call. If several unsuccessful incoming call attempts are received in a set time period, the modem locks out future incoming calls for a user-set number of hours.

When an incoming call is successfully connected, the control of communication is passed to the calling software program. The modem responds to computer commands to download data or other actions authorized by the meter passwords.

Refer to the *Communicator EXT User Manual* for instructions on programming the modem.

2.4.3: Dial-Out Function

The Dial-Out Function (INP2) is intended to allow the meter to automatically report certain conditions without user intervention. The modem polls the meter to determine if any abnormal or reportable conditions exist. The modem checks programmed meter conditions and programmed events (set in Communicator EXT software) to determine if a call should be placed.

If any of the monitored events exist, the modem automatically initiates a call to a specified location to make a report or perform some other function. For log full conditions, the meter automatically downloads the log(s) that are nearing the full condition.

2.5: Total Web Solutions

The 10/100BaseT Ethernet Option (INP200) is a fully customizable web server that uses XML to provide access to real time data via Internet Explorer. EIG's name for this dynamic system is Total Web Solutions. The system incorporates a highly programmable network card with built-in memory that is installed in the 100BaseT Option meters. Each card can be programmed to perform an extensive array of monitoring functions. The INP200 system is much faster than the 10BaseT Ethernet Option.

NOTE: Nexus® meters with the INP10 Option do not support Total Web Solutions.

2.5.1: Hardware Overview

The Nexus® 1250/1252 with the 10/100BaseT Ethernet Option (INP200) has all the components of the standard Nexus® 1250/1252 plus the capability of connection to a network through an Ethernet LAN or through the Internet via Modbus TCP, DNP3 LAN/WAN (1252 only), HTTP, SMTP, FTP and/or DHCP.

The Internal Network Option of the Nexus® meter is an extremely versatile communication tool. The INP200:

- Adheres to IEEE 802.3 Ethernet standard using TCP/IP
- Utilizes simple and inexpensive 10/100BaseT wiring and connections
- Plugs right into your network using built-in RJ45 jack
- Is programmable to any IP address, subnet mask and gateway requirements
- Communicates using the industry standard Modbus/TCP and DNP3 LAN/WAN over Ethernet (1252 only) protocols

2.5.2: Hardware Connection

Use Standard RJ45 10/100BaseT cable to connect with the Nexus® meter. The RJ45 line is inserted into the RJ45 Port on the face of a Nexus® meter with the INP200 Ethernet Option.

2.5.3: Software Overview

To make the software connection, follow these steps:

1. Using Port 1 or Port 4 (RS485 connection), connect a PC to the meter. An RS232/RS485 Converter may be required (Example: Electro Industries Unicom 2500).
2. Open Communicator EXT Software.
3. Click the Quick Connect or the Connection Manager icon in the Icon tool bar. In the Connect window that opens, click the Serial Port button. Make sure the connection data (such as Address) matches the meter and then click **Connect**.

2.5.4: Network Settings

Configure the Network Settings using the following steps (refer to the *Communicator EXT User Manual* for more details).

1. From Communicator EXT 's Main screen, click Profile to open the Device Profile screen.

2. From the Device Profile screen, double-click on the Communications Ports line, then double-click on any of the ports. The Communications Settings screen opens.

3. If you are going to use DHCP, click the Advanced Settings button and follow these steps:

   a. Click the DHCP tab at the top of the Advanced Settings screen.

   b. Click **Enable**. DHCP automatically enters the IP Address and some or all of the Interface Settings.

   c. Click **OK** at the bottom of the screen to return to the Communication Setting screen. You may have to manually enter DNS, Email, Gateway Setting and/or a unique computer name. Consult your Network Administrator if you are not sure of the correct information to enter.

   d. Click **OK**.

4. If you are not using DHCP, enter the following information in the Network Settings section of the Communication Settings screen (consult your system administrator if you are not sure of the information to enter):

   - IP Address: For example:10.0.0.1
   - Subnet Mask: For example: 255.255.255.0
   - Default Gateway: For example: 0.0.0.0
   - Computer Name: For example: NETWORK

5. Enter the Domain Name Server and Computer Name.

6. Default web pages with an extensive array of readings come with the meter. The content of the pages can be customized using FTP Client. Follow these steps:

   a. Click the **Advanced Settings** button in the Communications Settings screen.

   b. Click the FTP Client tab on the top of the Advanced Settings screen. Using FTP, you can easily replace any file by using the same file name as the one you want to replace.

   c. Click **OK**.

7. Enter the Email Server IP Address. The Default Settings store one Email Server IP Address for administrative purposes or to send an alarm, if there is a problem. An additional 8 email addresses can be configured with FTP Client.

8. Update Firmware, if necessary, with TFTP protocol (see Appendix C).

9. After the parameters are configured, Communicator EXT connects via the Network using a Device Address of "1" and the assigned IP Address when you follow these steps:

   a. Open Communicator EXT software.

   b. Click the **Connect** icon in the Icon tool bar to open the Connect screen.

   c. Click the **Network** button at the top of the screen and then enter the following information:

      - Device Address:1
      - Host: IP Address (per your network administrator). Example: 10.0.0.1
      - Network Port: 502
      - Protocol: Modbus TCP

   d. Click the **Connect** button at the bottom of the screen. Communicator EXT connects to the meter via the Network settings you entered.

2.6: Measurements and Calculations

The Nexus® 1250/1252 meter measures many different power parameters. Following is a list of the formulas used to perform calculations with samples for Wye and Delta services.

Samples for Wye: v_a, v_b, v_c, i_a, i_b, i_c, i_n

Samples for Delta: v_{ab}, v_{bc}, v_{ca}, i_a, i_b, i_c

Root Mean Square (RMS) of Phase Voltages: N = number of samples

For Wye: x = a, b, c

$$V_{RMS_x} = \sqrt{\frac{\sum_{t=1}^{N} v_{x(t)}^2}{N}}$$

Root Mean Square (RMS) of Line Currents: N = number of samples

For Wye: x =a, b, c, n

For Delta: x = a, b, c

$$I_{RMS_x} = \sqrt{\frac{\sum_{t=1}^{N} i_{x(t)}^2}{N}}$$

Root Mean Square (RMS) of Line Voltages: N = number of samples

For Wye: x, y= a,b or b,c or c,a

$$V_{RMS_{xy}} = \sqrt{\frac{\sum_{t=1}^{N} (v_{x_{(t)}} - v_{y_{(t)}})^2}{N}}$$

For Delta: xy = ab, bc, ca

$$V_{RMS_{xy}} = \sqrt{\frac{\sum_{t=1}^{N} v_{xy(t)}^2}{N}}$$

Power (Watts) per phase: N = number of samples

For Wye: x = a, b, c

$$W_X = \frac{\sum_{t=1}^{N} v_{x(t)} \bullet i_{x(t)}}{N}$$

Apparent Power (VA) per phase:

For Wye: x = a, b, c

$$VA_x = V_{RMS_X} \bullet I_{RMS_X}$$

Reactive Power (VAR) per phase:

For Wye: x = a, b, c

$$VAR_x = \sqrt{VA_x^2 - W_x^2}$$

Active Power (Watts) Total: N = number of samples

For Wye:

$$W_T = W_a + W_b + W_c$$

For Delta:

$$W_T = \frac{\sum_{t=1}^{N} (v_{ab(t)} \bullet i_{a(t)} - v_{bc(t)} \bullet i_{c(t)})}{N}$$

Reactive Power (VAR) Total: N = number of samples

For Wye:

$$VAR_T = VAR_a + VAR_b + VAR_c$$

For Delta:

$$VAR_T = \sqrt{(V_{RMS_{ab}} \bullet I_{RMS_a})^2 - \left[\frac{\sum_{t=1}^{N} v_{ab(t)} \bullet i_{a(t)}}{N}\right]^2} + \sqrt{(V_{RMS_{bc}} \bullet I_{RMS_c})^2 - \left[\frac{\sum_{t=1}^{N} v_{bc(t)} \bullet i_{c(t)}}{N}\right]^2}$$

Apparent Power (VA) Total:

For Wye:

$$VA_T = VA_a + VA_b + VA_c$$

For Delta:

$$VA_T = \sqrt{W_T^2 + VAR_T^2}$$

Power Factor (PF):

For Wye: x = a,b,c,T

For Delta: x = T

$$PF_x = \frac{W_x}{VA_x}$$

Phase Angles:

x = a, b, c

$$\angle_x = \cos^{-1}\left(PF_x\right)$$

% Total Harmonic Distortion (%THD):

For Wye: x = v_a, v_b, v_c, i_a, i_b, i_c

For Delta: x = i_a, i_b, i_c, v_{ab}, v_{bc}, v_{ca}

$$THD = \frac{\sqrt{\sum_{h=2}^{127}\left(RMS_{x_h}\right)^2}}{RMS_{x_1}}$$

K Factor: x = i_a, i_b, i_c

$$KFactor = \frac{\sum_{h=1}^{127}\left(h \bullet RMS_{x_h}\right)^2}{\sum_{h=1}^{127}\left(RMS_{x_h}\right)^2}$$

Watt hour (Wh): N = number of samples

$$Wh = \sum_{t=1}^{N} \frac{W_{(t)}}{3600_{sec/hr}}$$

VAR hour (VARh): N = number of samples

$$VARh = \sum_{t=1}^{N} \frac{VAR_{(t)}}{3600_{sec/hr}}$$

2.7: Demand Integrators

Power utilities take into account both energy consumption and peak demand when billing customers. Peak demand, expressed in kilowatts (kW), is the highest level of demand recorded during a set period of time, called the interval. The Nexus® 1250/ 1252 supports the following most popular conventions for averaging demand and peak demand: Block Window Demand, Rolling Window Demand, Thermal Demand, and Predictive Window Demand. You can program and access all conventions concurrently with the Communicator EXT software (see the *Communicator EXT User Manual*).

Block (Fixed) Window Demand:

This convention records the average (arithmetic mean) demand for consecutive time intervals (usually 15 minutes).

Example: A typical setting of 15 minutes produces an average value every 15 minutes (at 12:00, 12:15. 12:30. etc.) for power reading over the previous fifteen minute interval (11:45-12:00, 12:00-12:15, 12:15-12:30, etc.).

Rolling (Sliding) Window Demand:

Rolling Window Demand functions like multiple overlapping Block Window Demands. The programmable settings provided are the number and length of demand subintervals. At every subinterval, an average (arithmetic mean) of power readings over the subinterval is internally calculated. This new subinterval average is then averaged

(arithmetic mean), with as many previous subinterval averages as programmed, to produce the Rolling Window Demand.

Example: With settings of 3 five-minute subintervals, subinterval averages are computed every 5 minutes (12:00, 12:05, 12:15, etc.) for power readings over the previous five-minute interval (11:55-12:00, 12:00-12:05, 12:05-12:10, 12:10-12:15, etc.). In addition, every 5 minutes the subinterval averages are averaged in groups of 3 (12:00. 12:05, 12:10, 12:15. etc.) to produce a fifteen (5x3) minute average every 5 minutes (rolling (sliding) every 5 minutes) (11:55-12:10, 12:00-12:15, etc.).

Thermal Demand:

Traditional analog Watt-hour (Wh) meters use heat-sensitive elements to measure temperature rises produced by an increase in current flowing through the meter. A pointer moves in proportion to the temperature change, providing a record of demand. The pointer remains at peak level until a subsequent increase in demand moves it again, or until it is manually reset. The Nexus® 1250/1252 mimics traditional meters to provide Thermal Demand readings.

Each second, as a new power level is computed, a recurrence relation formula is applied. This formula recomputes the thermal demand by averaging a small portion of the new power value with a large portion of the previous thermal demand value. The proportioning of new to previous is programmable, set by an averaging interval. The averaging interval represents a 90% change in thermal demand to a step change in power.

Predictive Window Demand:

Predictive Window Demand enables the user to forecast average demand for future time intervals. The Nexus® uses the delta rate of change of a Rolling Window Demand interval to predict average demand for an approaching time period. The user can set a relay or alarm to signal when the Predictive Window reaches a specific level, thereby avoiding unacceptable demand levels. The Nexus® 1250/1252 calculates Predictive Window Demand using the following formula:

Example: Using the previous settings of 3 five-minute intervals and a new setting of 120% prediction factor, the working of the Predictive Window Demand could be described as follows:

At 12:10, we have the average of the subintervals from 11:55-12:00, 12:00-12:05 and 12:05-12:10. In five minutes (12:15), we will have an average of the subintervals 12:00-12:05 and 12:05-12:10 (which we know) and 12:10-12:15 (which we do not yet know). As a guess, we will use the last subinterval (12:05-12:10) as an approximation for the next subinterval (12:10-12:15). As a further refinement, we will assume that the next subinterval might have a higher average (120%) than the last subinterval. As we progress into the subinterval, (for example, up to 12:11), the Predictive Window Demand will be the average of the first two subintervals (12:00-12:05, 12:05-12:10), the actual values of the current subinterval (12:10-12:11) and the prediction for the remainder of the subinterval, 4/5 of the 120% of the 12:05-12:10 subinterval.

# of Subintervals = n

Subinterval Length = Len

Partial Subinterval Length = Cnt

Prediction Factor = Pct

Sub_n		Sub_1	Sub_0	Partial	Predict
Len		Len	Len	Cnt	Len

$$Sub = \frac{\sum_{i=0}^{Len-1} Value_i}{Len}$$

$$Partial = \frac{\sum_{i=0}^{Cnt-1} Value_i}{Cnt}$$

$$\left[Partial + \frac{\sum_{i=0}^{n-2} Value_i}{n} \right] \times \left[1 - \left[\left[\frac{Len - Cnt}{Len} \right] \times Pct \right] \right]$$

$$+ \left[\frac{\sum_{i=0}^{n-2} Sub_i}{n-1} + \frac{Sub_0 - Sub_{n-1}}{2x(n-1)} \right] \times \left[\left[\frac{Len - Cnt}{Len} \right] \times Pct \right]$$

2.8: Nexus® External I/O Modules (Optional)

The following multiple analog or digital I/O modules mount externally to the Nexus® 1250/1252 meter. The Nexus® 1250/1252 meter supplies 12VA to its ports. You may need to use additional power supplies, such as EIG's 12V PSIO, to extend I/O capability. See Sections 5.6.2 to determine power needed; see Section 3.3 for mounting diagrams; and see Chapter 9 for details on installation and use of the Nexus® External I/O modules.

Analog Transducer Signal Outputs

- 1mAON4: 4 Analog Outputs, self powered, scalable, bidirectional
- 1mAON8: 8 Analog Outputs, self powered, scalable, bidirectional
- 20mAON4: 4 Analog Outputs, self powered, scalable
- 20mAON8: 8 Analog Outputs, self powered, scalable

Analog Transducer Inputs

- 8AI1: 8 Analog Inputs 0–1mA, scalable and bidirectional
- 8AI2: 8 Analog Inputs 0–20mA, scalable
- 8AI3: 8 Analog Inputs 0–5V DC, scalable
- 8AI4: 8 Analog Inputs 0–10V DC, scalable

Digital Dry Contact Relay Outputs

- 4RO1: 4 Relay Outputs 10 Amps, 125V AC, 30V DC, Form C

Digital Solid State Pulse Outputs

- 4PO1: 4 Solid State Pulse Outputs, Form A KYZ pulses

Digital Inputs

- 8DI1: 8 Digital status inputs Wet/Dry Auto Detect, up to 300V AC/DC

Other I/O Accessories

- PSIO: 12V power supply for I/O modules and external displays
- MBIO: Bracket for surface-mounting I/O modules to any enclosure

2.9: Nexus® 1250 / 1252 Meter Specifications

UL Measurement Category - Category III

Rated Altitude - 2,000 Meters Maximum

Specification	Nexus® meter
Control Power Requirement	Option D: 24VDC (-20%) to 48 VDC (+20%)
	Option D2: 120V AC/DC (-20%) to 230VAC (+20%)
Connection Screws' Torque	(6 to 9) in-lb max. or (0.68 to 1) Nm max.
Input Voltage Range	150 Volts Phase to Neutral, 300V Phase to Phase (Standard; for use with PTs)
	300 Volts Phase to Neutral, 600V Phase to Phase (Option G)
Voltage Input Withstand Capability	Meets ANSI C37.90.1 Surge withstand capability
	Voltage inputs optically isolated to 2500VDC
Input Current Range	10A Max. (Programmable to any CT Ratio)
	Fault Current recording to 60A peak secondary based on 5A Full Scale **NOTE**: 1A and 0.25A current inputs are available by special order.
Current Input Terminals	8-32 Threaded Studs; The current inputs are only to be connected to external current transformers
Current Input Withstand Capability (at 23° C)	Continuous rating - 20A
	Surge - 100A/10 secs, 300A/3 secs, 500A/1 sec
Burden	Voltage: 0.05VA @120V rms
	Current: 0.002VA @5A rms
Isolation	All inputs and outputs - 2500V
	All Com ports are isolated from each other
Sensing Method	RMS

Specification	Nexus® meter
Update Time	200msec - High-speed readings
	1 sec - Revenue-accurate reading
Frequency Range	Fundamental 20-65Hz
	Up to 255th Harmonic Measuring Capability
Dimensions (HxWxL)	3.4 x 7.3 x 10.5 in/8.6 x 18.5 x 26.6 cm
Maximum Power Consumption	40 Watts (with optional modules and display)
Nominal Power Consumption	Approximately 12 Watts (without optional modules or display)
Operating Temperature	(-40 to +70)°C/(-40 to +158)°F
Auxiliary Output Power Voltage	15-20VDC at 5-200mA
Maximum Auxiliary Power Current	1A (short protected)
Maximum Power Supply Range	(100-250)VAC
UL Listing	61010-1 (not evaluated for accuracy, reliability, or capability to perform intended function)
Flicker (Nexus® 1252)	Evaluation per IEC 61000-4-15
EN50160/IEC 61000-4-30 PQ Analysis	Evaluation per IEC 61000-4-30*
IRIG-B Port Impedance	8mA@5V

* EN50160/EN61000-4-30 PQ Analysis is only available for a Nexus® 1252 meter with V- Switch™ key 2.

2.10: Nexus® P40N+, P41N+, P43N+ LED External Display Specifications

Specification	P40N+/P41N+/P43N+ Displays
Maximum Input Voltage	30VDC
Minimum Input Voltage	12VDC
Maximum Power Consumption	5W
Nominal Power Consumption	Approximately 3W
Operating Temperature Range	(-20 to +70)°C/(-4 to +158)°F
Overall Dimensions (HxWxD)	*5.25 x 5.25 x1.79 inches/13.34 x 13.34 x 4.54 cm

* The legacy P40N dimensions are: 4.4 x 4.4 x 2.2 inches/11.1 x 11.1 x 5.9cm.

2.11: Upgrading the Nexus® 1252 Meter's V-Switch™ Key

The Nexus® 1252 meter's base configuration is V-Switch™ key 1(V-1). To upgrade your meter to a higher V-Switch™ key (e.g., V-2), follow these steps:

1. Obtain a V-Switch™ upgrade key by contacting EIG's inside sales staff at sales@electroind.com or by calling 516-334-0870 (USA). You will be asked for the following information:

   a. Serial number(s) of the meter you are upgrading.

   b. Desired V-Switch™ upgrade.

   c. Credit card or Purchase Order number.

2. EIG will issue you the V-Switch™ upgrade key. To enable the key, follow these steps:

   a. Open Communicator EXT software.

   b. Power up your Nexus® meter.

   c. Connect to the meter via Communicator EXT. (See Chapter 3 of the *Communicator EXT User Manual* for detailed instructions: you can open the manual online by clicking **Help>Contents** from the Communicator EXT Main screen).

   d. Click **Tools>Change V-Switch™** from the Title Bar of the Main screen. A screen opens, requesting the encrypted key.

   e. Enter the upgrade key provided by EIG.

   f. Click **OK**. The V-Switch™ key is enabled and the meter is reset.

NOTE: The Nexus® 1250 meter does not have a V-Switch™ key upgrade.

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3: Hardware Installation

This chapter provides installation information for the Nexus® 1250/1252 meter and its optional modules and displays.

3.1: Mounting the Nexus® 1250 / 1252 Meter

The Nexus® 1250/1252 Meter is designed to mount against any firm, flat surface. Use a #10 screw in each of the four slots on the flange to ensure that the unit is installed securely. For safety reasons, mount the meter in an enclosed and protected environment, such as in a switchgear cabinet. Install a switch or circuit breaker nearby; label it clearly as the meter's disconnecting mechanism.

NOTE: The Nexus® meter with the Internal Modem Option mounts the same way.

Maintain the following conditions:

- Operating Temperature: -40°C to +70°C / -40°F to +158°F
- Storage Temperature: -40°C to +70°C / -40°F to +158°F
- Relative Humidity: 5 to 95% non-condensing

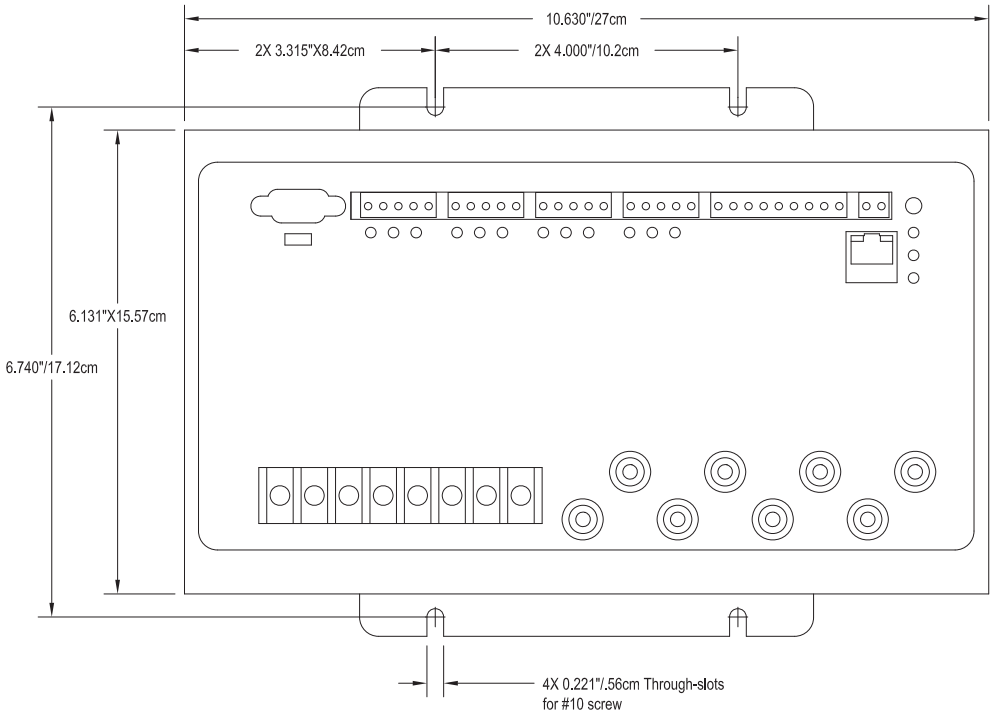


Figure 3.1: Nexus® 1250/1252 Mounting Diagram Top View

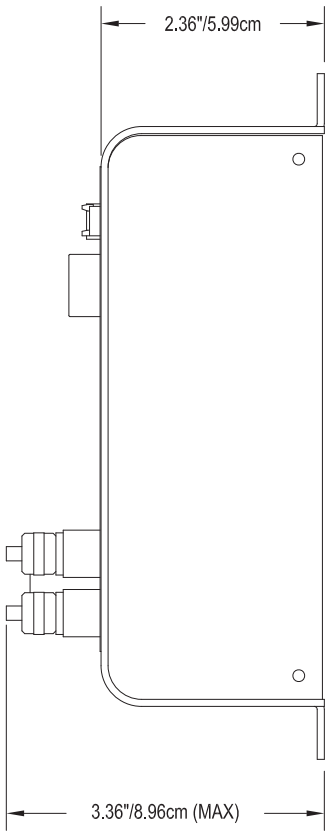


Figure 3.2: Nexus® 1250/1252 Mounting Diagram Side View

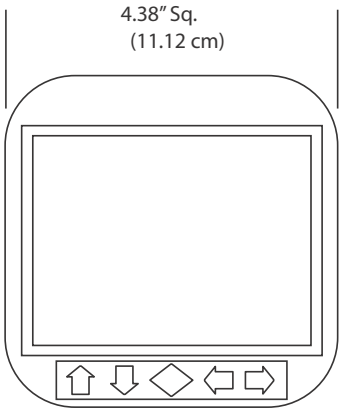
3.2: Mounting the Nexus® LED External Displays

The Nexus® 1250/1252 LED displays (model numbers P40N+, P41N+ and P43N+) mount using a standard ANSI C39.1 drill plan.

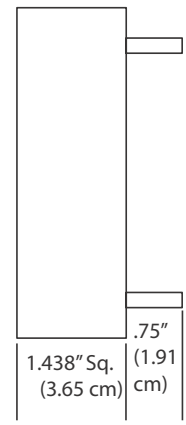
Secure the four mounting studs to the back of the panel with the supplied nuts.

Six feet of RS485 communication/power cable harness is supplied. Allow for at least a 1.25-inch (3.17cm) diameter hole in the back for the cable harness. See Chapter 5 for communication and power supply details.

The cable harness brings power to the display from the Nexus® 1250/1252 meter, which supplies 15–20V DC. The P40N+ (or P41N+ or P43N+) can draw up to 500mA in display test mode.



P40N Front Dimensions



P40N Side Dimensions

NOTE: The P40N is not intended for new applications.

P40N+ Display

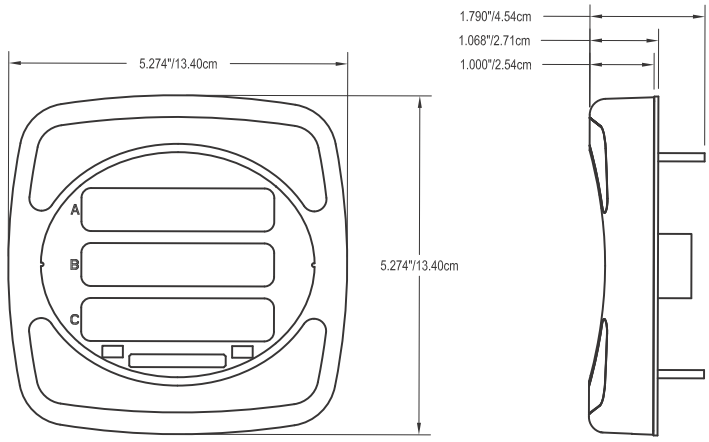


Figure 3.3: Legacy P40N and P40N+ Dimensions

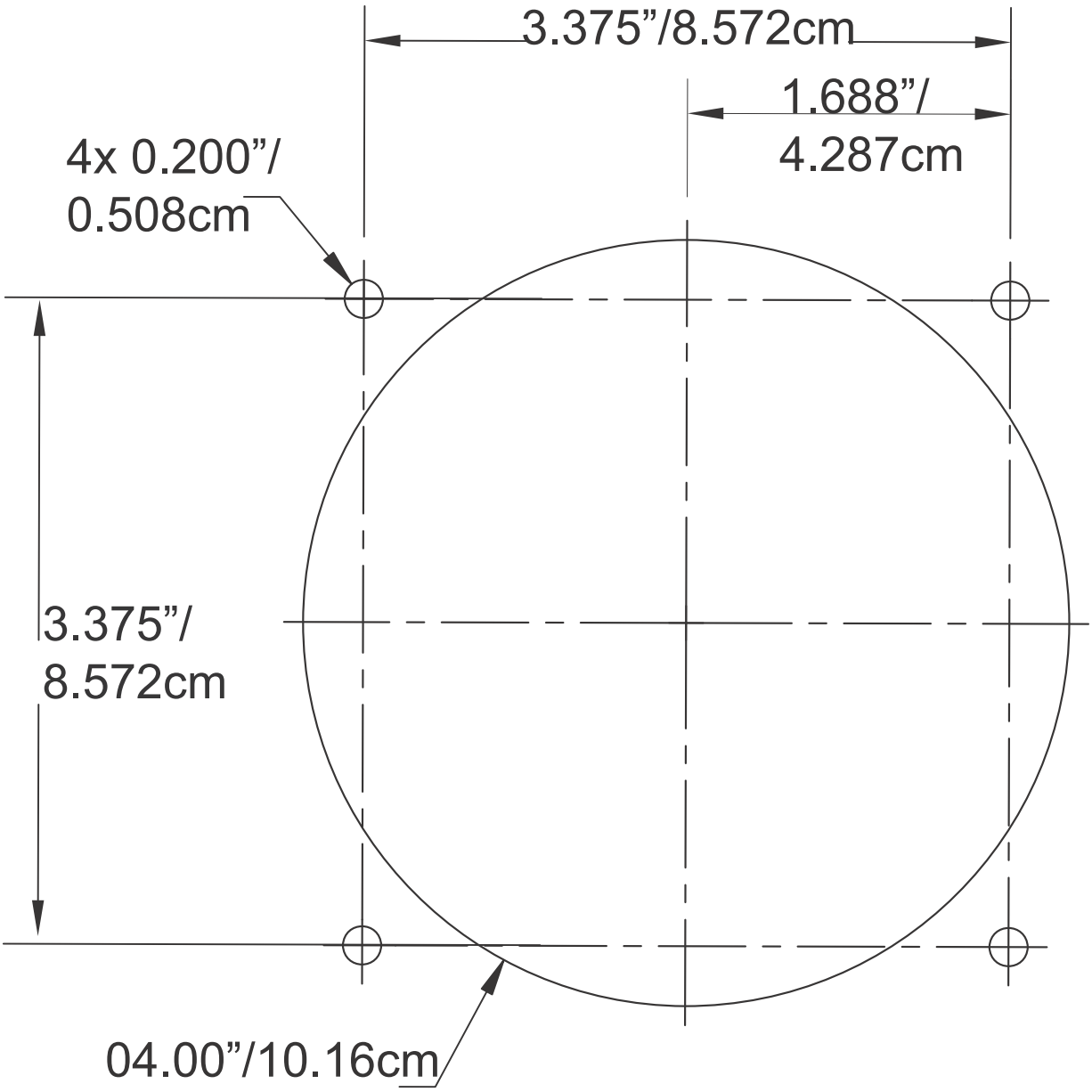


Figure 3.4: ANSI C39.1 Drill Plan for P40N/P40N+ Display

3.3: Mounting the Nexus® External I/O Modules

Secure the mounting brackets to the I/O using the screws supplied (#440 pan-head screws). Next, secure the brackets to a flat surface using a #8 screw with a lock washer.

If multiple I/O modules are connected together, as shown in Figure 3.5, secure a mounting bracket to both ends of the group. One Nexus® will supply power for a number of I/O modules. See Sections 5.6.2 to see if you need to use an additional power supply, such as the EIG PSIO. Connect multiple I/O modules using the RS485 side ports.

Six feet of RS485 cable harness is supplied. The cable harness brings power to the display from the Nexus® meter. See Chapter 5 for power supply and communication details.

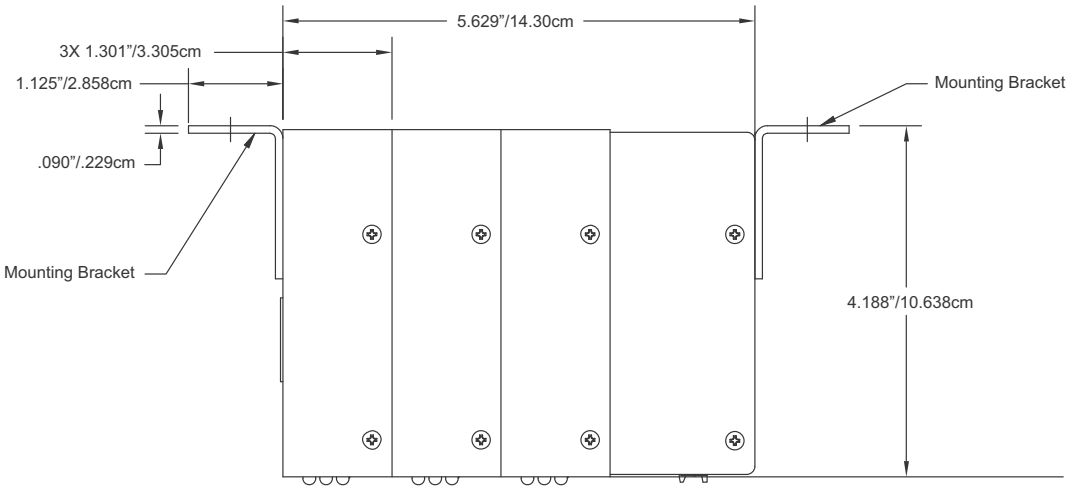


Figure 3.5: I/O Modules Mounting Diagram Overhead View

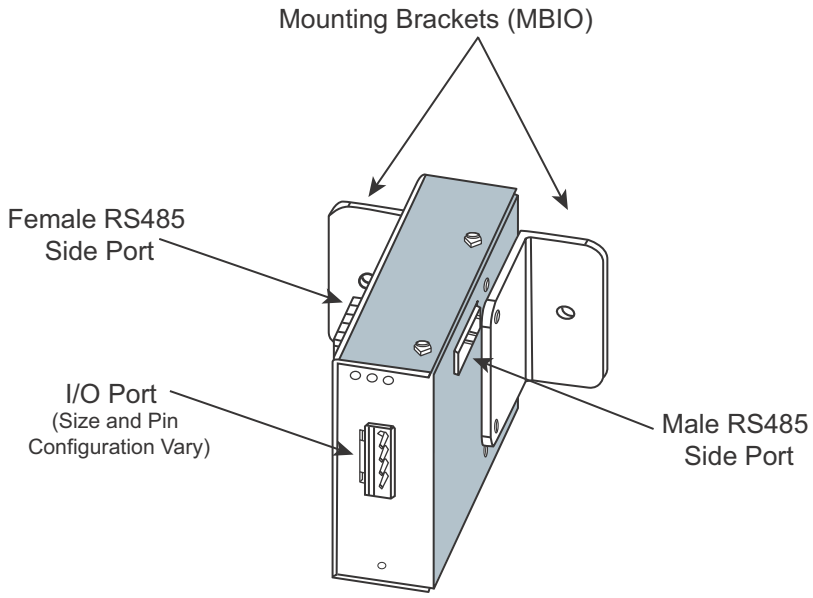


Figure 3.6: I/O Module Communication Ports and Mounting Brackets

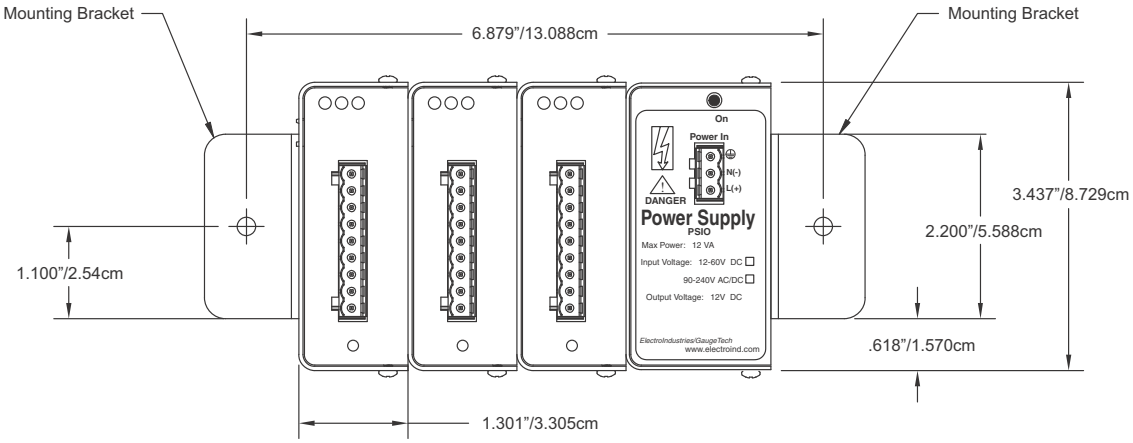


Figure 3.7: I/O Modules Mounting Diagram Front View

4: Electrical Installation

This chapter provides electrical installation information for the Nexus® 1250/1252 meter.

4.1: Considerations When Installing Meters

Installation of the Nexus® 1250/1252 meter must be performed only by qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing are recommended.

During normal operation of the Nexus® meter, dangerous voltages flow through many parts of the unit, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules and their circuits. **All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces**.

Do not use the meter or any I/O device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection.

Do not use the meter for applications where failure of the meter may cause harm or death.

Do not use the meter for any application where there may be a risk of fire.

All meter terminals should be inaccessible after installation.

Do not apply more than the maximum voltage the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages. Do not HIPOT/Dielectric test any Outputs, Inputs or Communications terminals.

EIG recommends the use of Fuses for voltage leads and power supply, and shorting blocks to prevent hazardous voltage conditions or damage to CTs, if the meter needs to be removed from service. **CT grounding is optional**.

The current inputs are only to be connected to external current transformers.

To comply with UL standards, the meter case must be connected to a reliable protective earth available within the installation area. For this connection use minimum #14 AWG wire crimped to a ring terminal(3) with a dedicated tool. Fasten the ring terminal(3) to the lower left slot of the meter case with minimum #6 metal screw(1) and star washer(2), as is shown in Figure 4.1.

The UL Classification of the meter is Measurement Category III, Pollution Degree 2.

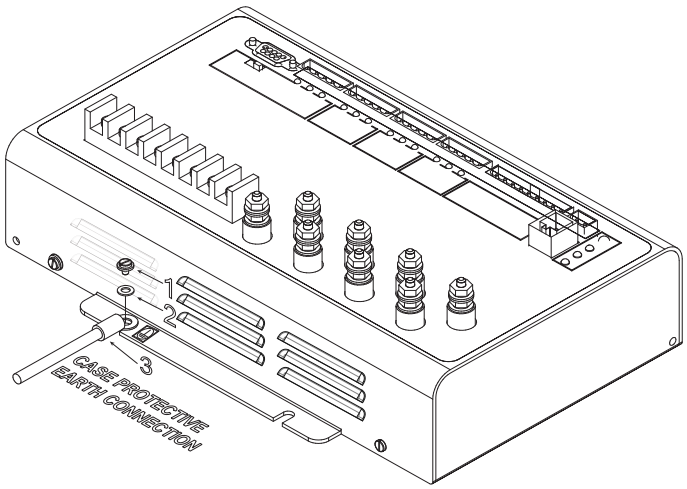


Figure 4.1: Meter Case's Earth Ground Connection

NOTE: IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

NOTE: THERE IS NO REQUIRED PREVENTIVE MAINTENANCE OR INSPECTION NECESSARY FOR SAFETY. HOWEVER, ANY REPAIR OR MAINTENANCE SHOULD BE PERFORMED BY THE FACTORY.

DISCONNECT DEVICE: The following part is considered the equipment disconnect device.

A SWITCH OR CIRCUIT-BREAKER SHALL BE INCLUDED IN THE END-USE EQUIPMENT OR BUILDING INSTALLATION. THE SWITCH SHALL BE IN CLOSE PROXIMITY TO THE EQUIPMENT AND WITHIN EASY REACH OF THE OPERATOR. THE SWITCH SHALL BE MARKED AS THE DISCONNECTING DEVICE FOR THE EQUIPMENT.

4.2: Wiring the Monitored Inputs and Voltages

Select a wiring diagram from Section 4.9 that best suits your application. Wire the Nexus® 1250/1252 meter exactly as shown. For proper operation, the voltage connection must be maintained and must correspond to the correct terminal. Program the CT and PT Ratios in the Device Profile section of the Communicator EXT software; see the *Communicator EXT User Manual* for details.

The cable required to terminate the voltage sense circuit should have an insulation rating greater than 600V AC and a current rating greater than 0.1 Amp.

Use a minimum of 14 AWG wire for all phase voltage and current connections.

The maximum installation torque for both the current input terminals and the voltage connections is 1 Newton-Meter.

4.3: Fusing the Voltage Connections

For accuracy of the readings and for protection, EIG requires using 0.25-Amp rated fuses on all voltage inputs as shown in the wiring diagrams (see Section 4.9).

The Nexus® 1250/1252 meter can handle a maximum voltage of 150V phase to neutral and 300V phase to phase. Potential Transformers (PTs) are required for higher voltages with the standard rating. With Option G, the direct voltage input is extended to 300V phase to neutral and 600V phase to phase.

NOTE: Option G is only intended for use with direct connections. For PT connections, use the standard 150 Volt version.

4.4: Wiring the Monitored Inputs - VRef

The Voltage Reference connection references the monitor to ground or neutral.

4.5: Wiring the Monitored Inputs - VAux

The Voltage Auxiliary connection is an auxiliary voltage input that can be used for any desired purpose, such as monitoring neutral to ground voltage or monitoring two different lines on a switch. The VAux Voltage rating is the same as the metering Voltage input connections.

4.6: Wiring the Monitored Inputs - Currents

Install the cables for the current at 600VAC minimum insulation. The cable connector should be rated at 10 Amps or greater and have a cross-sectional area of 14 AWG.

Mount the current transformers (CTs) as close as possible to the meter. The following table illustrates the maximum recommended distances for various CT sizes, assuming the connection is via 14 AWG cable.

EIG Recommendations

CT size (VA)	Maximum Distance from CT to Nexus® Meter (Ft)
2.5	10
5	15
7.5	30
10	40
15	60
30	120

WARNING! DO NOT leave the secondary of the CT open when primary current is flowing. This may cause high voltage, which will overheat the CT. If the CT is not connected, provide a shorting block on the secondary of the CT.

It is important to maintain the polarity of the CT circuit when connecting to the Nexus® 1250/1252 meter. If the polarity is reversed, the meter will not provide accurate readings. CT polarities are dependent upon correct connection of CT leads and the direction CTs are facing when clamped around the conductors. Although shorting blocks are not required for proper meter operation, EIG recommends using shorting blocks to allow removal of the Nexus® 1250/1252 meter from an energized circuit, if necessary.

4.7: Isolating a CT Connection Reversal

For a Wye System, you may either:

- Check the current phase angle reading on the meter's external display (see Chapter 6). If it is negative, reverse the CTs.
- Go to the Phasors screen of the Communicator EXT software (see Chapter 3 of the *Communicator EXT User Manual* for instructions). Note the phase relationship between the current and voltage: they should be in phase with each other.

For a Delta System:

- Go to the Phasors screen of the Communicator EXT software program (see Chapter 3 of the *Communicator EXT User Manual* for instructions). The current should be 30 degrees off the phase-to-phase voltage.

4.8: Instrument Power Connections

The Nexus® 1250/1252 meter requires a separate power source.

To use AC power:

1. Connect the line supply wire to the L+ terminal
2. Connect the neutral supply wire to the N- terminal on the meter.

To use DC power:

1. Connect the positive supply wire to the L+ terminal.
2. Connect the negative (ground) supply wire to the N- terminal on the meter.

Power supply options and corresponding suffixes are listed in the table shown on the next page.

Control Power	Option Suffix
18-60 Volts DC	D
90-276 Volts AC/ DC	D2

- Do not ground the unit through the negative of the DC supply. **Separate grounding is required.**
- Externally fuse the power supply with a 5 Amp @250V rated slow blow fuse. EIG recommends that you fuse **both** the L+ and N- connections for increased safety, but if you are fusing only one connection, fuse the L+ connection.
- Use at least 14 Gauge supply wire for the power supply and ground connections.

NOTE ON CORRECT METER FUNCTIONING:

The Nexus® 1250/1252 meter has a Heartbeat LED, located on the top, right side of the meter face. When the meter is functioning correctly, the red LED pulse toggles on and off (blinks) 5 times per second. If the meter is not functioning correctly, the Heartbeat LED slows to one pulse per second

4.9: Wiring Diagrams

Choose the diagram that best suits your application. Diagrams appear on the following pages. If the connection diagram you need is not shown, contact EIG for acustom Connection diagram.

NOTE: If you purchased a "G" Option Nexus® 1250/1252 meter for a 300 Volt secondary, be sure to enable the option on the CT and PT screen of the Communicator EXT software's Device Profile (see Chapter 3 of the *Communicator EXT User Manual* for instructions). Do not use the "G" option with PTs. It is intended for direct Voltage connection, only.

Figure #	Description
4.2	4-Wire Wye, 3-Element Direct Voltage with 4 CTs
4.3	4-Wire Wye, 3-Element with 3 PTs and 4 CTs
4.4	4-Wire Wye, 3-Element with 3 PTs and 3 CTs
4.5	3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs
4.6	3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs
4.7	3-Wire, 2-Element Delta Direct Voltage with 3 CTs
4.8	3-Phase, 4-Wire Wye, 2.5 Element with 2 PTs and 3 CTs
4.9	4-Wire, 3-Element Grounded Delta with 4 CTs - G Option

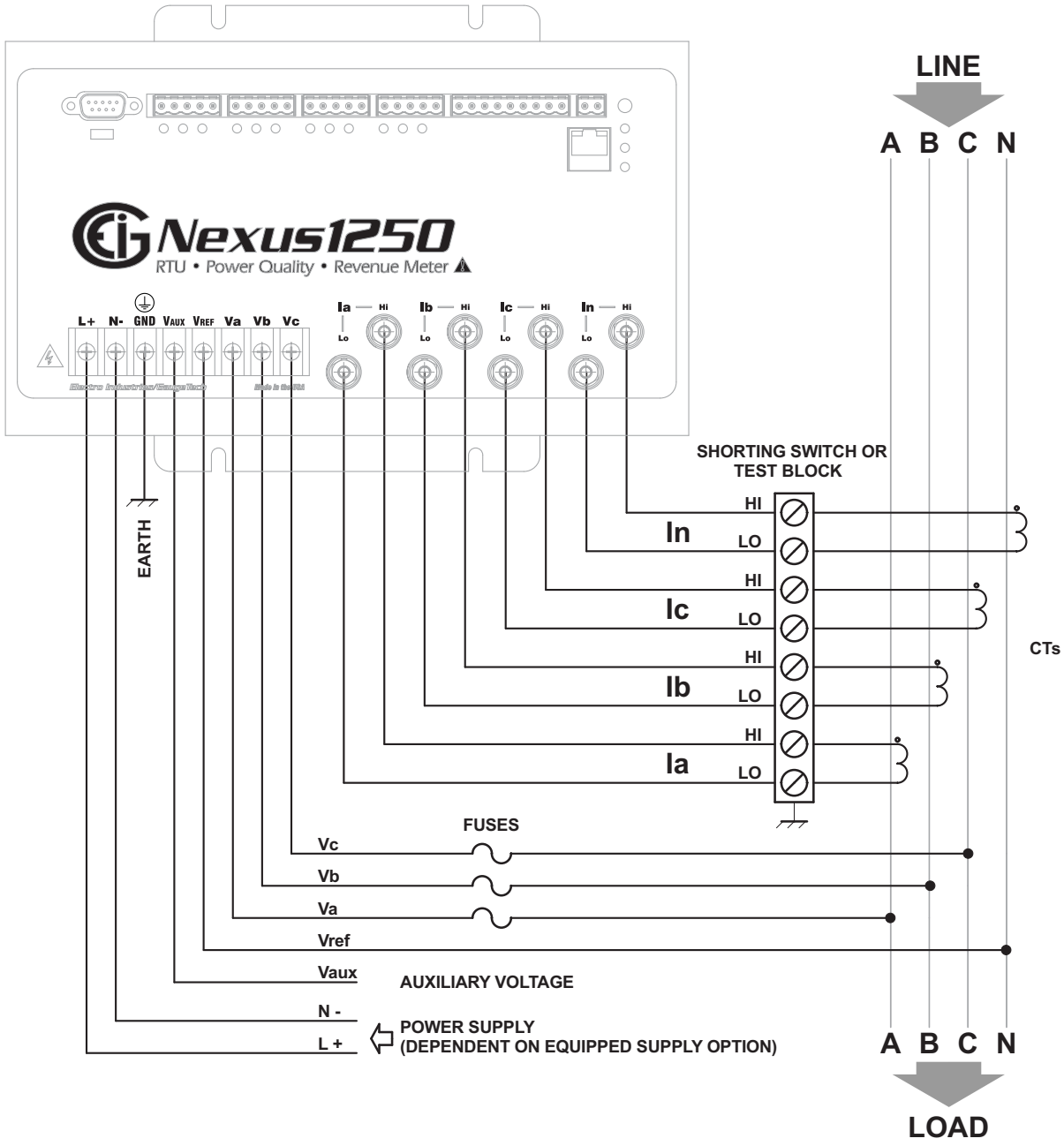


Figure 4.2: 4-Wire Wye, 3-Element Direct Voltage with 4 CTs

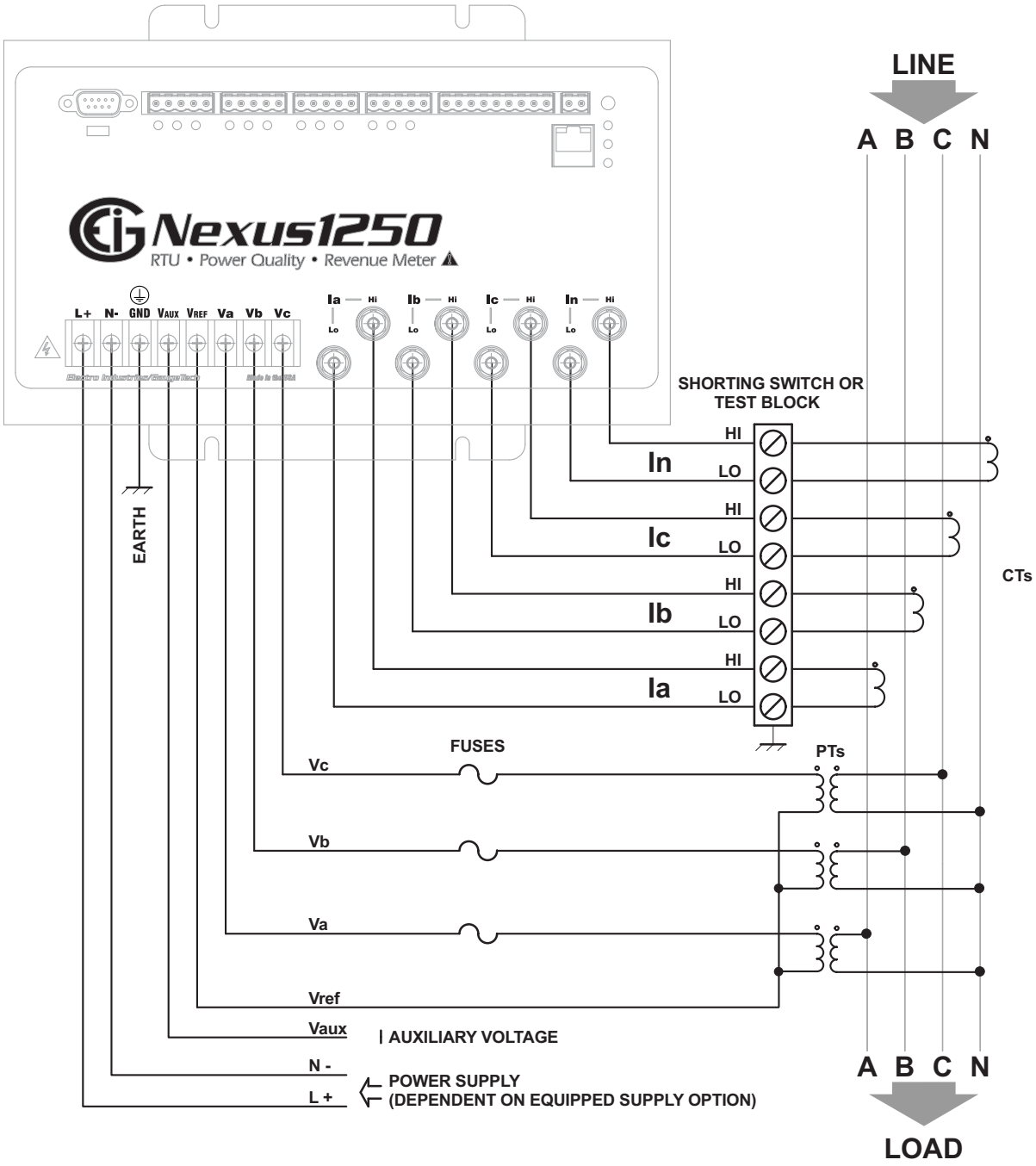


Figure 4.3: 4-Wire Wye, 3-Element with 3 PTs and 4 CTs

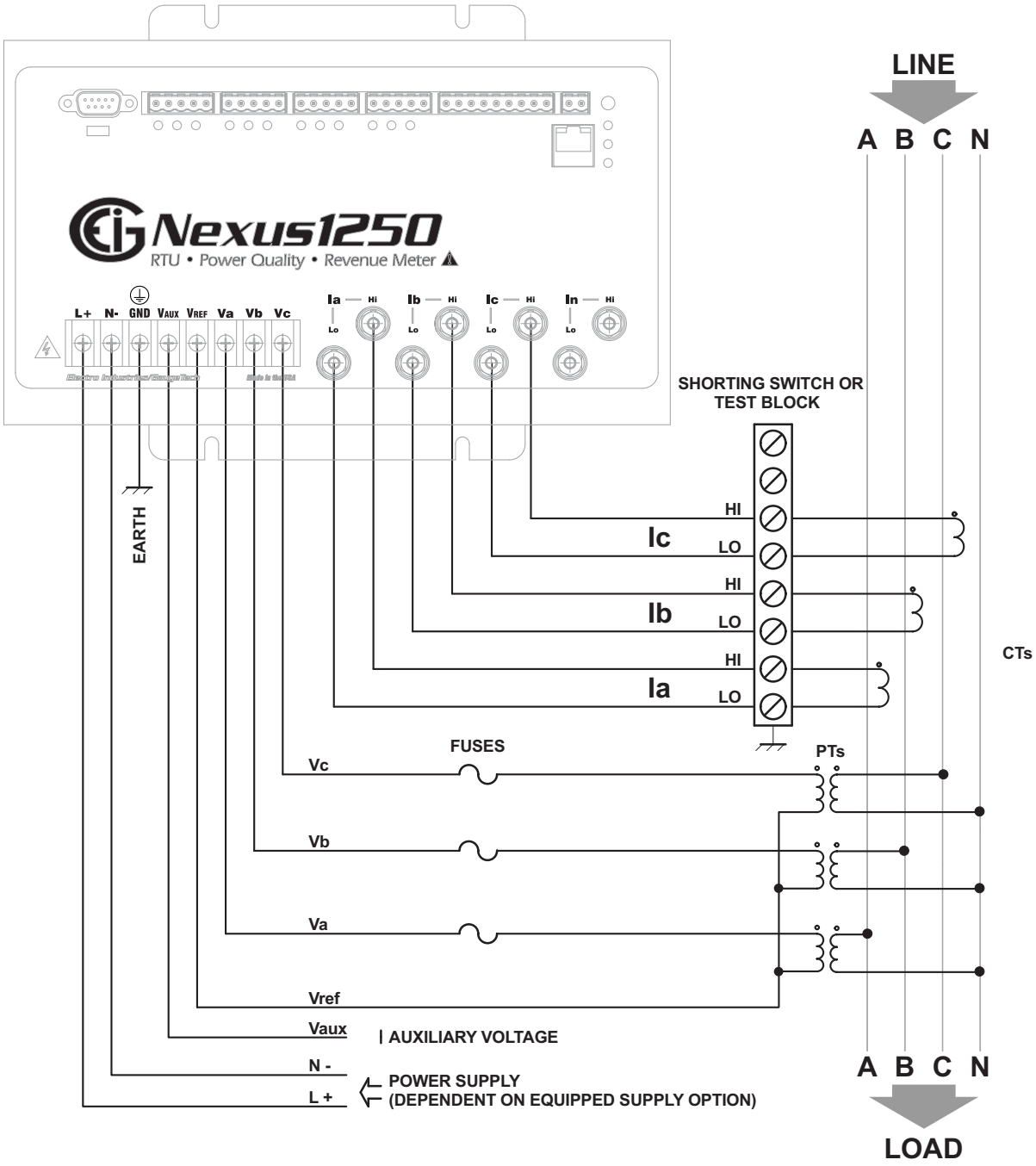


Figure 4.4: 4-Wire Wye, 3-Element with 3 PTs and 3 CTs

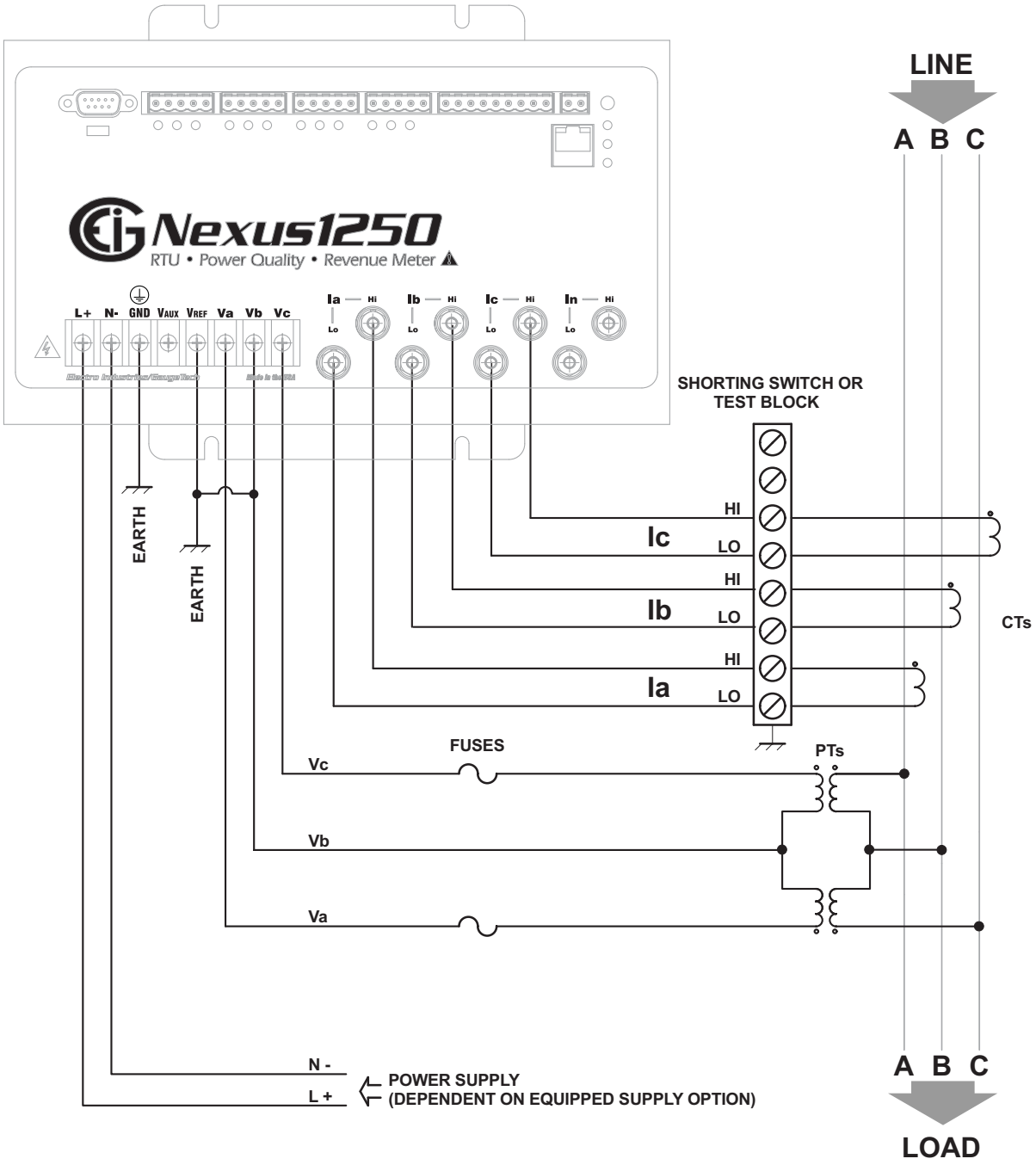


Figure 4.5: 3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs

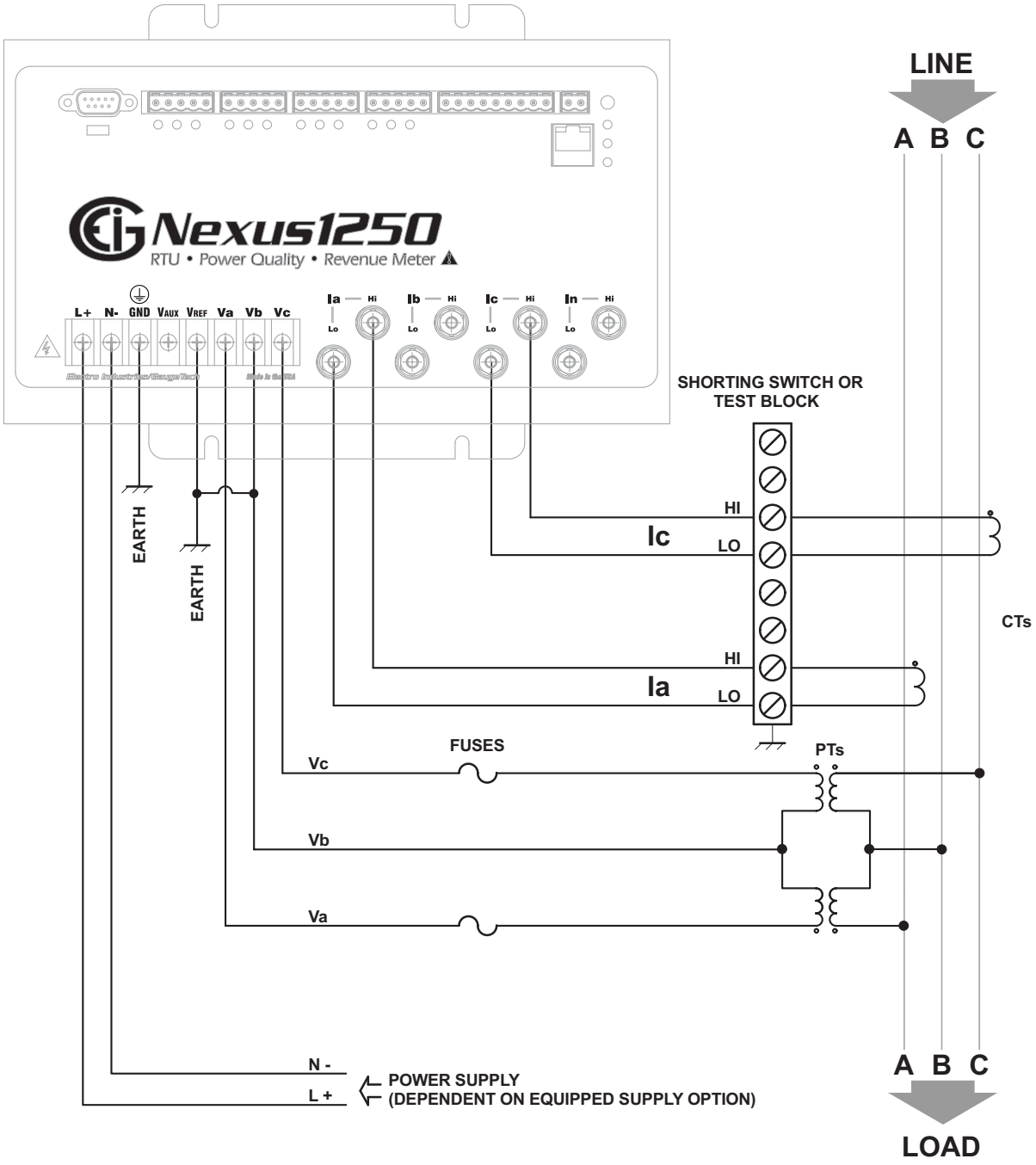


Figure 4.6: 3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs

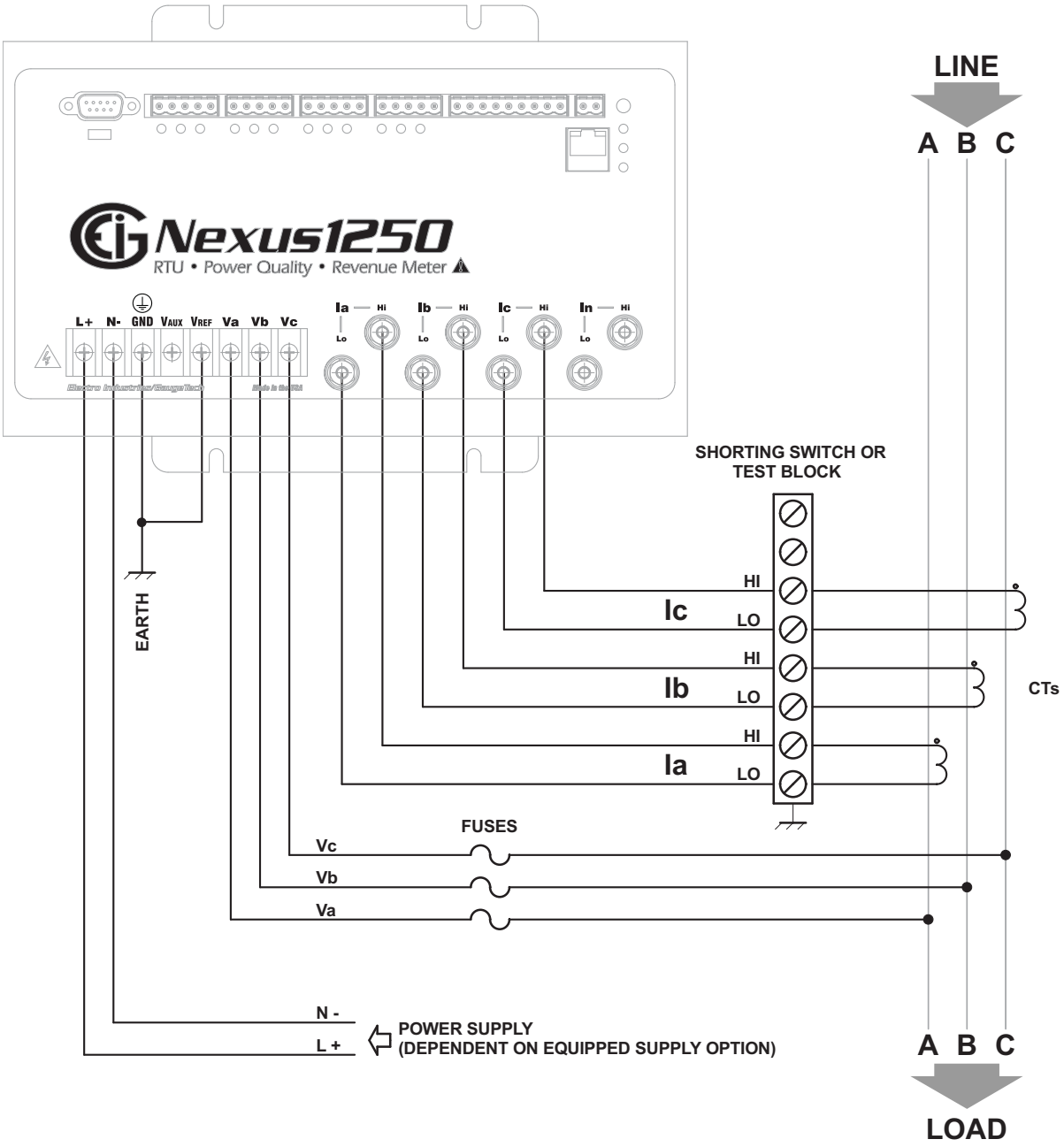


Figure 4.7: 3-Wire, 2-Element Delta Direct Voltage with 3 CTs

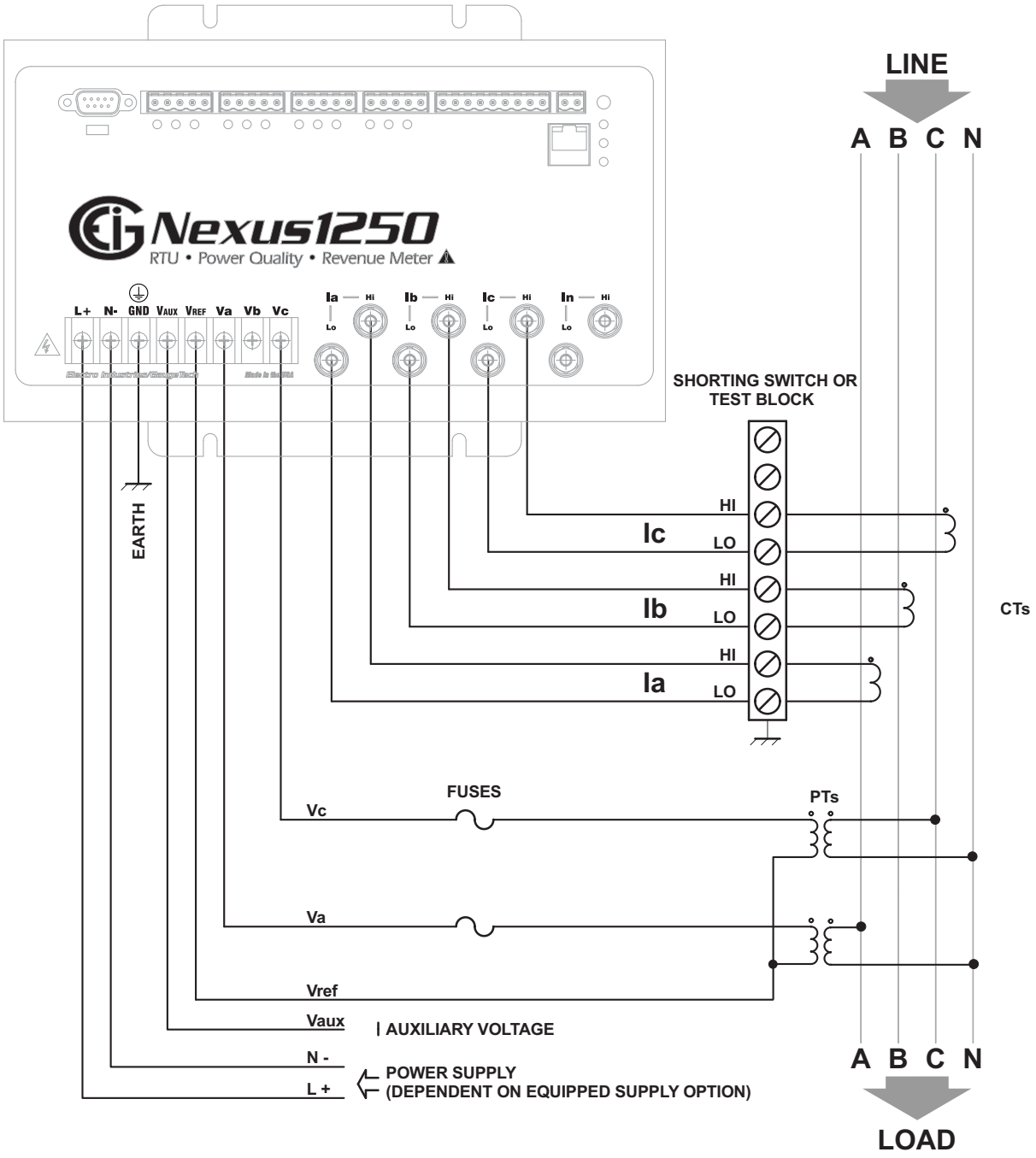


Figure 4.8: 3-Phase, 4-Wire, 2.5 Element with 2 PTs and 3 CTs

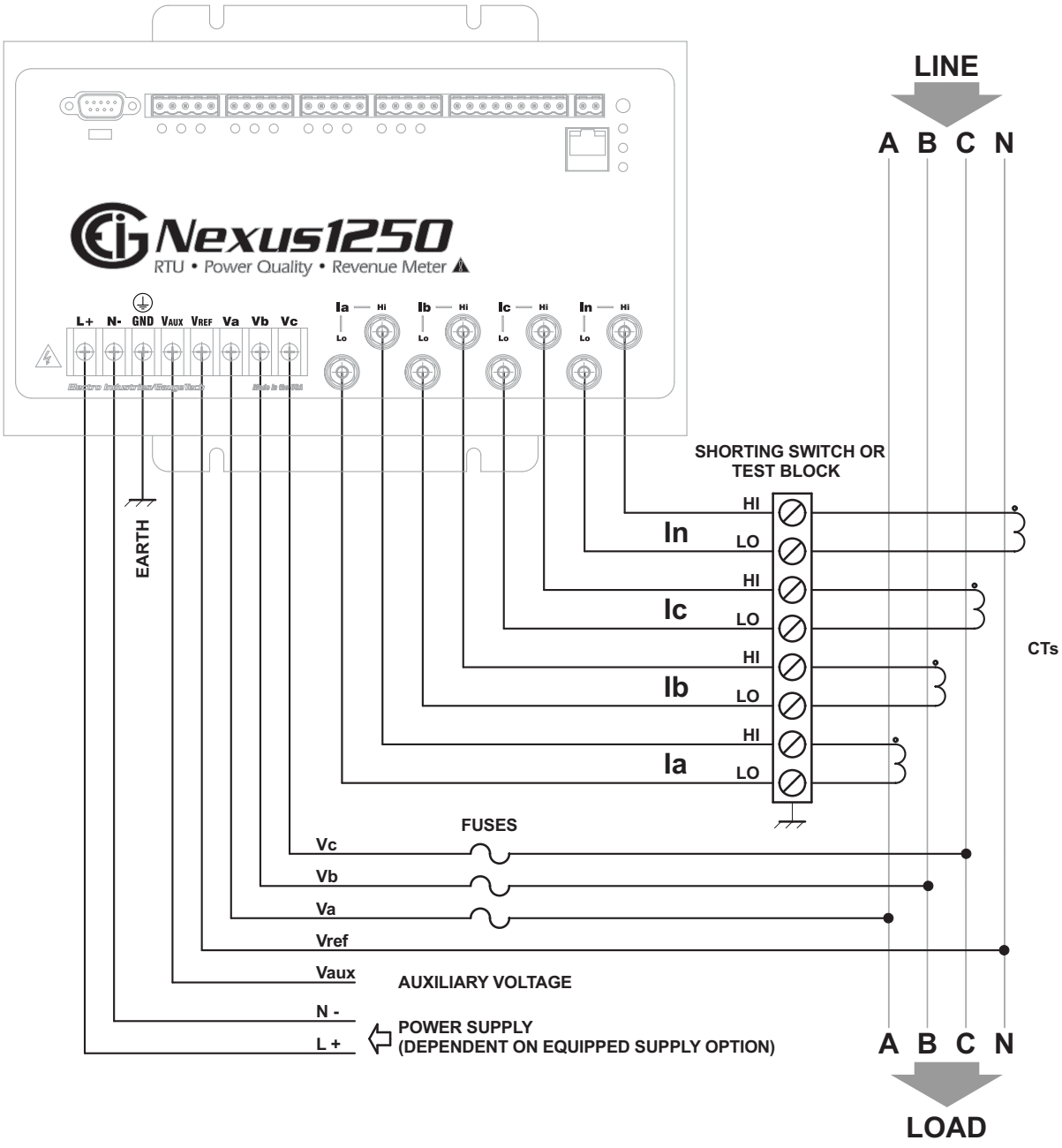


Figure 4.9: 4-Wire, 3-Element Grounded Delta with 4 CTs - G Option

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5: Communication Wiring

This chapter provides wiring information for the Nexus® 1250/1252 meter's communication options.

5.1: Communication Overview

RS232 communication is used to connect a single Nexus® 1250/1252 meter with another device, such as a computer, RTU or PLC. The link is viable for a distance of up to 50 feet (15.2 meters) and is available only through the meter's Port 1. You must set the selector switch beneath the port to RS232.

RS485 communication allows multiple Nexus® meters to communicate with another device at a local or remote site. The I/O modules and the Nexus® displays use RS485 to communicate with the Nexus® meter. All RS485 links are viable for a distance of up to 4000 feet (1220 meters). Ports 1 through 4 on the Nexus® 1250/1252 meter are two-wire, RS485 connections operating up to 115200 baud. To use Port 1 for RS485, set the selector switch to RS485 (the switch is located under the port).

RJ11 Telephone Line allows a Nexus® 1250/1252 meter with the Internal Modem Option (INP2) to communicate with a PC. No other hardware is necessary for this easy-to-use connection. For more details, see Chapter 10.

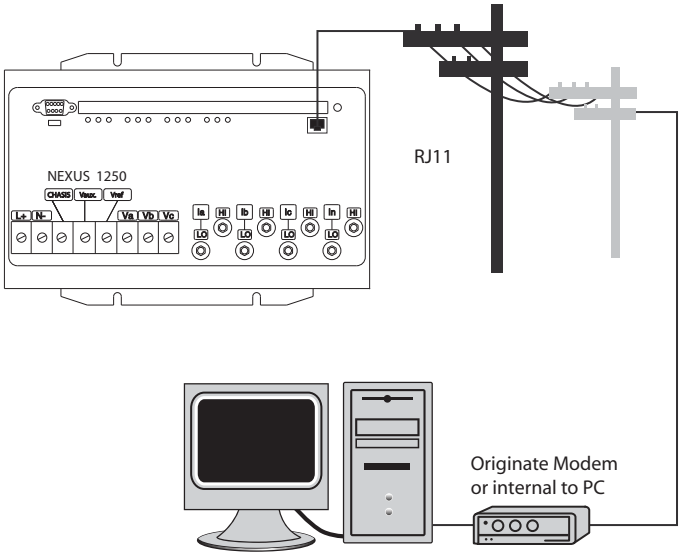


Figure 5.1: RJ11 Communication with Internal Modem Option

RJ45 Network Connection allows a Nexus® 1250/1252 meter with the Internal Network Option (INP200) to communicate with multiple PC's simultaneously. No other hardware is necessary for this easy-to-use connection.

In a Nexus® meter with INP200, Port 2 becomes a Gateway for connecting multiple Nexus® meters using RS485.

See Chapter 11 for INP200 details.

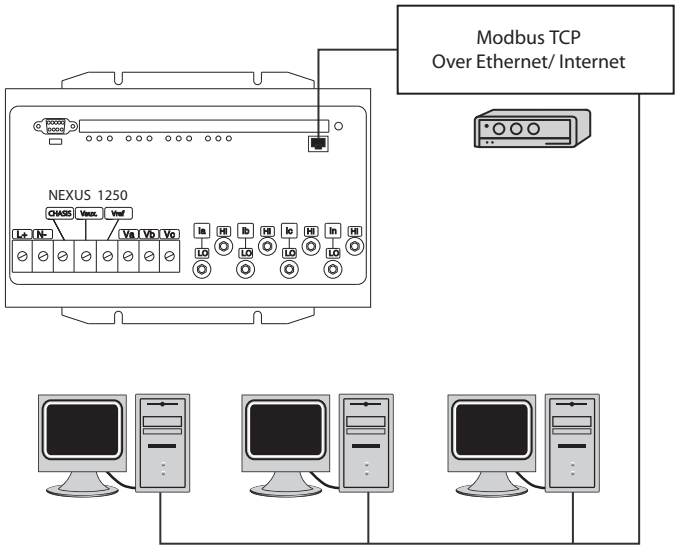


Figure 5.2: RJ45 Communication with Internal Network Option

NOTE: Nexus® 1252 meters can also communicate with DNP 3.0 protocol over Ethernet.

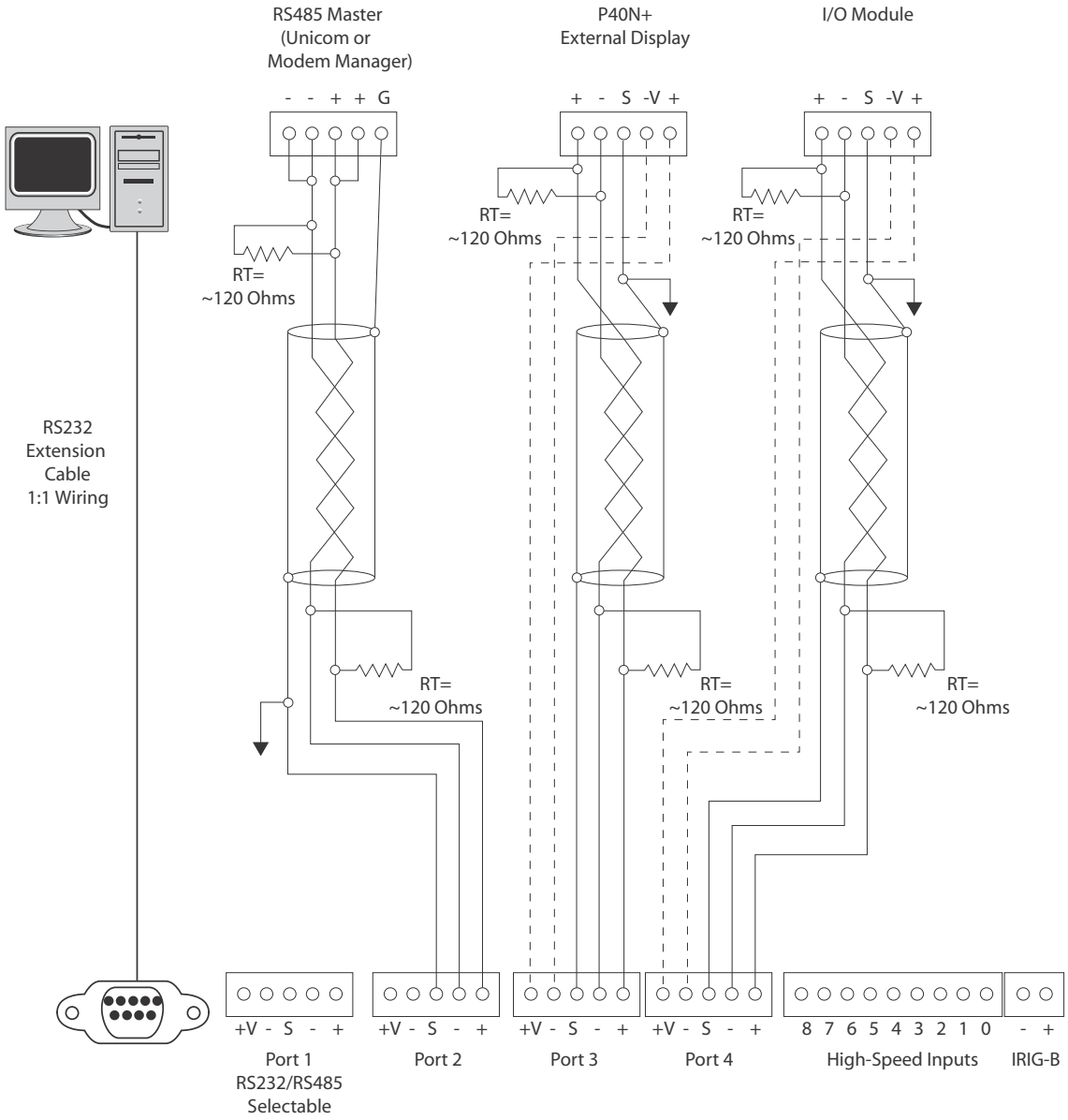


Figure 5.3: Communication Wiring

NOTES:

- I/O Modules and External Displays require power connections to the +/- Voltage terminals (dashed lines).
- For all communications: S=Shield. This connection is used to reference the Nexus® meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**

- You can use ANY port to connect a Nexus® display or RS485 Master. The I/O modules use Port 3 or Port 4. Nexus® P40N+, P41N+ and P43N+ displays are shipped pre-programmed to use Port 3—see Section 5.3.4 for details.

5.2: RS232 Connection (Port 1)

- Use Port 1 for RS232 communication. Set the selector switch beneath the port to RS232.
- Insert one end of an RS232 extension cable into the Nexus® 1250/1252 meter's 9-pin female serial port. Insert the opposite end into a port on the computer.
- The RS232 standard limits the cable length to 50 feet (15.2 meters).
- The RS232 Port is configured as Data Communications Equipment (DCE).

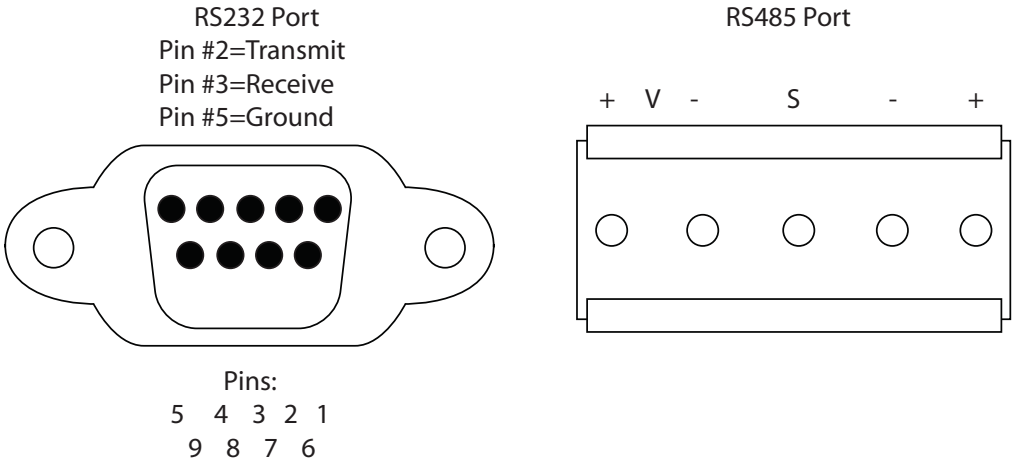


Figure 5.4: RS232/RS485 Port Detail

5.3: RS485 Communication

RS485 communication allows multiple devices to communicate on a bus. The Nexus® 1250/1252 meter's Ports 1 to 4 are RS485 terminals, viable for a distance of up to 4000 feet (1219 meters). (Port 1 can be switched between RS232 and RS485.) The following figure shows wiring detail of a 2-wire RS485 port.

Figure 5.5: 2-Wire RS485 Port Detail

All of the Nexus® 1250/1252 meter's RS485 ports have the following connections:

- +V- (Voltage terminals for power connections): use with Nexus® I/O Modules and Displays only. The Nexus® 1250/1252 meter supplies 17V DC through the +V- terminal connections.

  NOTE: Do not connect these pins to devices that receive power from another source—e.g., a computer—or to devices that do not require power to operate.

- S (Shield): the Shield connection is used to reference the meter's port to the same potential as the source. It is not an earth-ground connection. You must also connect the shield to earth-ground at one point. Do not connect the shield to ground at multiple points, as this will interfere with communication.

- +/- (Two-wire, RS485 communication terminals): connect the + terminal of the Nexus® meter's port to the + terminal of the device; connect the - terminal of the Nexus® meter's port to the - terminal of the device.

NOTES on RS485 Communication:

- Use a shielded twisted pair cable 22 AWG (0.33 mm2) or larger, grounding the shield at one end only.

- Establish point-to-point configurations for each device on an RS485 bus: connect (+) terminals to (+) terminals; connect (-) terminals to (-) terminals.

- Protect cables from sources of electrical noise.

- Avoid both "star" and "tee" connections (see Figure 5.6). No more than two cables should be connected at any one point on an RS485 network, whether the connections are for devices, converters or terminal strips.

- Include all segments when calculating the total cable length of a network. If you are not using an RS485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219 meters).

- RT EXPLANATION: Termination Resistors are generally used on both ends of longer length transmission lines. The value of the Termination Resistors is determined by the electrical parameters of the cable. Use RTs only on Master and Last Slave when connecting multiple meters in a Daisy Chain.

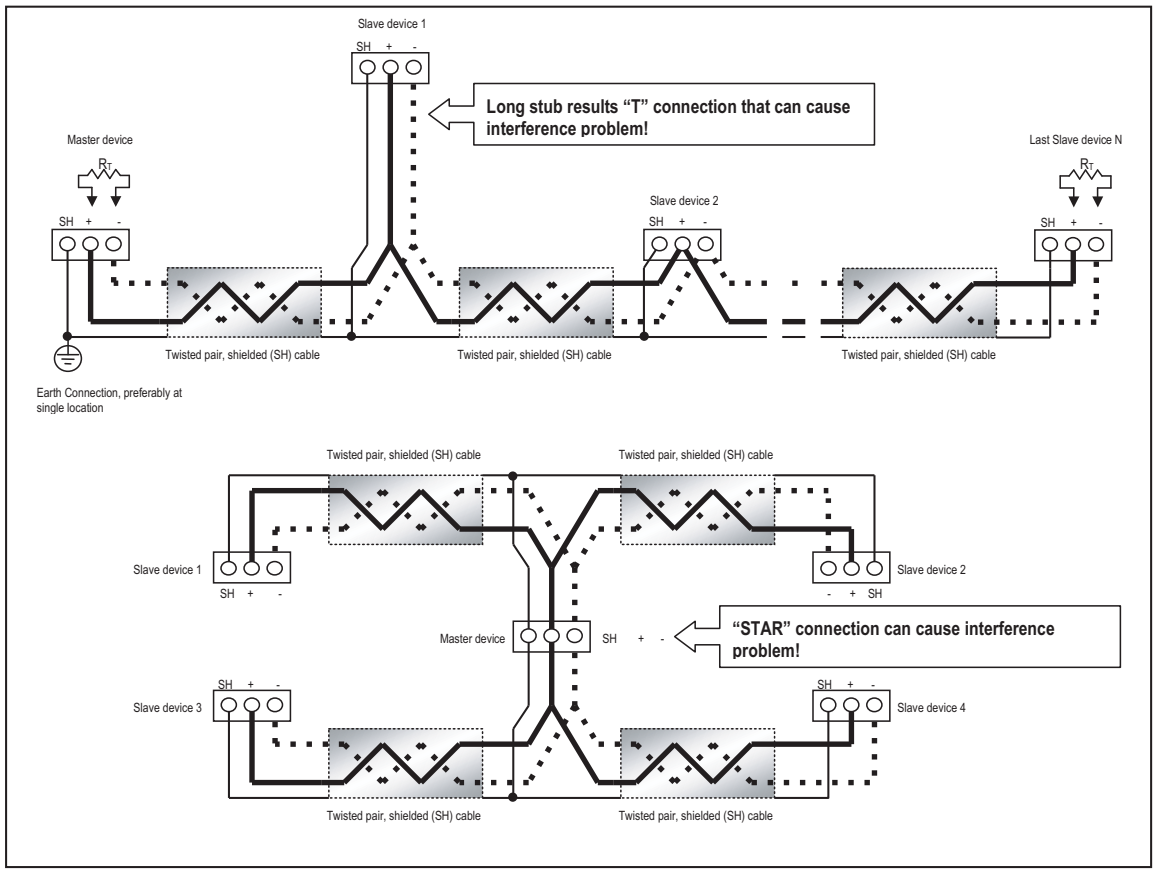


Figure 5.6: Incorrect "T" and "Star" Topologies

5.3.1: RS485 Connection

- Use any Port on the Nexus® 1250/1252 meter. If you use Port 1, set the selector switch beneath the port to RS485.
- The link using RS485 is viable for up to 4000 feet (1219 meters).
- You must use an RS485 to RS232 converter, such as EIG's Unicom 2500. See sections 5.3.2 and 5.3.3.
- For information on connecting the Nexus® 1250/1252 meter to a modem, see sections 5.8.2 and 5.8.3.
- Do not use the V(+)/V(-) pins: they supply power to the Nexus® displays and I/O modules.

5.3.2: Connection to an RS485 Master (Unicom or Modem Manager)

- To establish communication between a Nexus® 1250/1252 meter and any RS485 master, such as EIG's Unicom 2500, Modem Manager or other RS232/RS485 converter, use a shielded, twisted pair cable.
- Use an RS485 port (Ports 1–4) on the Nexus® meter. If you use Port 1, set the selector switch beneath it to RS485. Connect the (+) and (-) terminals on the meter to the (+) and (-) terminals on the master. Provide jumpers on the master, linking its two (-) terminals and two (+) terminals. RS485 communication is viable for up to 4000 feet (1219 meters).
- Connect the shield to the Ground (G) terminal on the Master. The (S) terminal on the Nexus® meter is used to reference the Nexus® meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
- Provide resistors at each end, connected to the (+) and (-) lines. RT is approximately 120 Ohms, but this value may vary based on length of cable run, gauge and the impedance of the wire. See RT EXPLANATION in Section 5.3.

5.3.3: Using the Unicom 2500

The Unicom 2500 provides RS485/RS232 conversion. In doing so it allows the Nexus® 1250/1252 meter to communicate with a PC or other device. See the *Unicom 2500 Installation and Operation Manual* for additional information. You can order the Unicom 2500 from EIG's webstore: www.electroind.com/store. Select the Communications Products category from the left side of the webpage.

Figure 5.7 illustrates the Unicom 2500 connections for RS485.

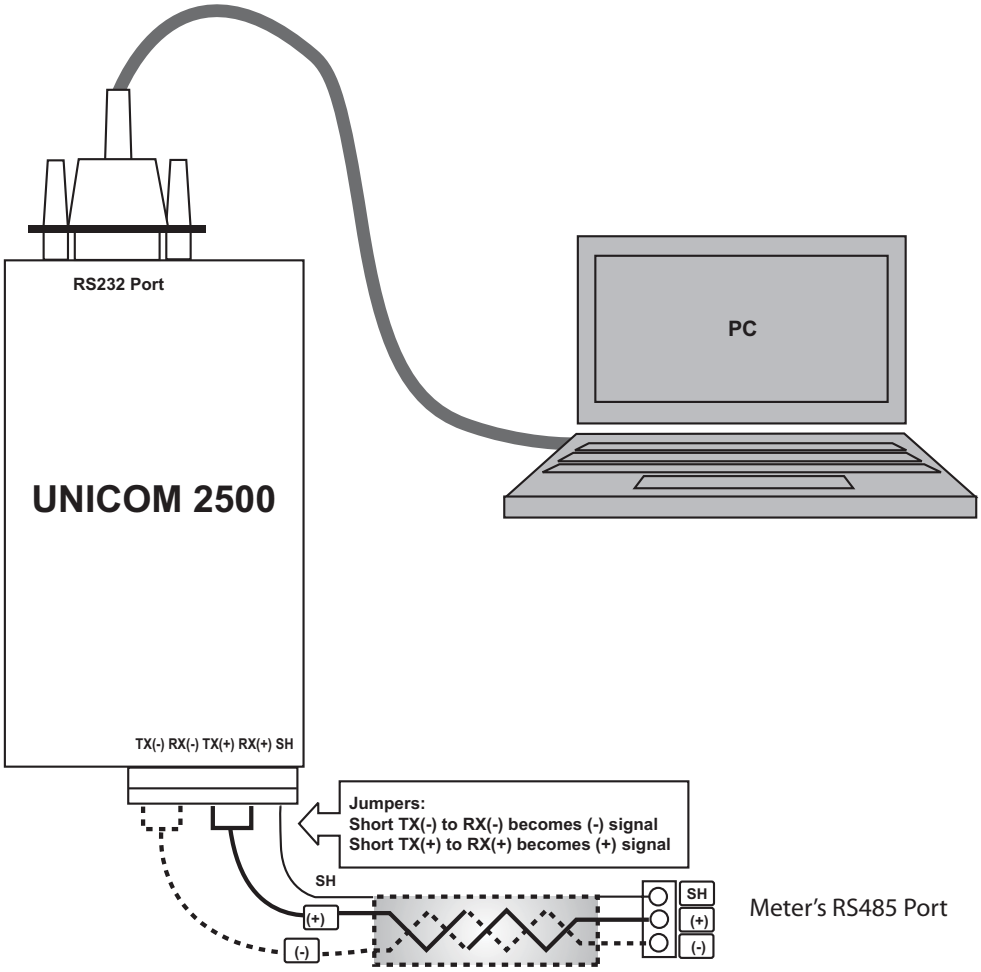
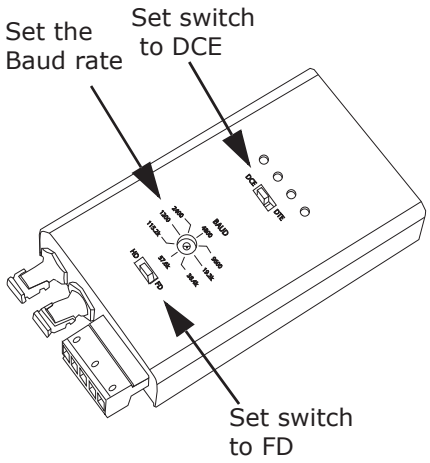


Figure 5.7: Meter Connected to PC using Unicom 2500

The Unicom 2500 can be configured for either 4-wire or 2-wire RS485 connections. Since the Nexus® meter uses a 2-wire connection, you need to add jumper wires to convert the Unicom 2500 to the 2-wire configuration.

As shown in Figure 5.7, you connect the "RX-" and "TX-" terminals with a jumper wire to make the "-" terminal, and connect the "RX+" and "TX+" terminals with a jumper wire to make the "+" terminal. See the figure on the right for the Unicom 2500's settings. The Unicom's Baud rate must match the Baud rate of the meter's RS485 port: you set the Baud rate by turning the screw to point at the rate you want.



5.3.4: RS485 Connection to the Nexus® P40N+ External Display

Insert one end of the supplied RS485 cable into Port 3 of the Nexus® 1250/1252 meter. Port 3 is factory-set to match the Nexus® display's baud rate of 9600. To use a port other than Port 3, you must set the port's baud rate to 9600 using the Communicator EXT software (see Chapter 3 of the Communicator EXT User Manual for instructions). Insert the other end of the cable into the back of the Nexus® P40N/P40N/+, P41N+ or P43N+ display. (The connectors fit only one way into the ports.)

The cable harness brings 17V DC to the displays from the Nexus® meter. RS485 communication is viable for up to 4000 feet (1219 meters). If your cable length exceeds 200 feet you must use a remote power supply, such as EIG's PSIO, and:

1. Connect the shield to the shield (S) terminal on the Nexus® display port. The (S) terminal on the Nexus® meter is used to reference the Nexus® meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**

2. Provide termination resistors at each end, connected to the + and - lines. RT is approximately 120 Ohms. See RT EXPLANATION in Section 5.3.

5.4: RJ11 (Telephone Line) Connection—Nexus® Meter with Internal Modem Option (INP2) to a PC

Use RJ11 Standard Telephone Line to connect with the Nexus® 1250/1252 meter. For details on this connection, see Chapter 10.

5.5: RJ45 Connection—Nexus® Meter with Internal Network Option (INP200) to Multiple PCs - 10/100BaseT

The Internal Network Option conforms to the IEEE 802.3, 10BaseT and 100BaseT specification using unshielded twisted pair (UTP) wiring. This allows the use of inexpensive RJ45 connectors and CAT 3 or better cabling. For details on this connection, see Chapter 11.

5.6: Communication Ports on the Nexus® I/O Modules

- Female RS485 Side Port: use to connect to another module's female RS485 side port.
- Male RS485 Side Port: use to connect to the Nexus® meter's Port 3 or Port 4, or to connect to another module's male RS485 side port.
- I/O Port: use for functions specific to the type of module; size and pin configuration varies depending on type of module.
- For more detail, refer to the following section and Chapter 9.

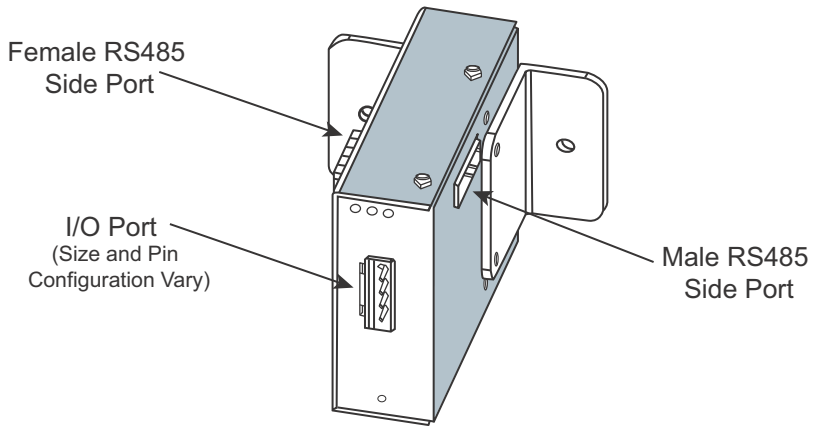


Figure 5.8: I/O Module Communication Ports

5.6.1: RS485 Connection—Nexus® Meter to Nexus® I/O Modules

- Six feet of RS485 cable harness is supplied. Insert one end of the cable into Port 3 or Port 4 of the Nexus® 1250/1252 meter.

- Insert the other end of the cable into the I/O module's female RS485 side port (see Figure 5.8). The connectors fit only one way into the ports.

- Use the male RS485 side port to attach another I/O module. The Nexus® 1250/1252 meter can power up to four connected I/O modules using 15–20V DC at 50–200mA. Use the steps in Section 5.6.2 to determine if you must use a separate power source (for example, EIG's PSIO) to supply added power to the group. See Section 9.2.1 for information on the PSIO. RS485 communication is viable for up to 4000 feet (1219 meters). However, if your cable length exceeds 200 feet, use the remote power supply and:

  1. Connect the + and - terminals on the Nexus® meter to the + and - terminals of the female RS485 port. Connect the shield to the shield (S) terminal. The (S) terminal on the Nexus® meter is used to reference the meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**

  2. Provide termination resistors at each end, connected to the + and - lines. RT is approximately 120 Ohms. See RT EXPLANATION in Section 5.3

5.6.2: Steps to Determine Power Needed

Available power for all ports of the Nexus® 1250/1252 meter is 12 VA.

1. Refer to the tables on the next two pages to determine the VA Ratings for I/O modules and displays.

2. Add together the VA Ratings for all I/O modules and displays in use.

3. Compare available power to power needed to determine if you must use an additional power source.

NOTE: EIG recommends the PSIO 12V power source if the I/O module VA rating exceeds the Nexus® specification. See Section 9.2.1 for information and usage instructions.

I/O Module Factory Settings and VA Ratings			
Model#	Module	Address	VA Rating
1mAON4	0-1mA, 4 Analog Outputs	128	2.7VA
1mAON8	0-1mA, 8 Analog Outputs	128	3.2VA
20mAON4	4-20mA, 4 Analog Outputs	132	5.0VA
20mAON8	4-20mA, 8 Analog Outputs	132	8.5VA
8AI1	0-1mA, 8 Analog Inputs	136	2.3VA
8AI2	0-20mA, 8 Analog Inputs	140	2.3VA
8AI3	0-5VDC, 8 Analog Inputs	144	2.3VA
8AI4	0-10VDC, 8 Analog Inputs	148	2.3VA
4RO1	4 Latching Relay Outputs	156	2.7VA
4PO1	4 KYZ Pulse Outputs	160	2.7VA
8DI1	8 Status Inputs (Wet/Dry)	164	1.0VA

As the table above shows, all I/O modules are shipped pre-programmed with a baud rate of 57600 and addresses. For programming instructions, refer to Chapter 8 of the *Communicator EXT User Manual*.

See the next page for the external displays' VA Ratings.

NOTE: For 24 or 48 VDC applications, EIG recommends the PB1 power supply.
Example order number: PB1-D-12VO (PB1)

If you are using a PSIO (for 125V AC/DC input) or PB1 your maximum VA is 12.

Nexus® Display VA Ratings		
P41N+/P41N+/ P43N+	LED Displays	8VA

5.7: Linking Multiple Nexus® Meters in Series

You may connect a total of 31 Nexus® meters in series on a single bus using RS485. The cable length may not exceed 4000 feet (1219 meters). Before assembling the bus, each Nexus® meter must be assigned a unique address. See Chapter 3 of the *Communicator EXT User Manual* for instructions.

- Connect the + and - terminals of each Nexus® meter. Use jumpers on any RS485 Master connected at the end of the chain.
- Connect the shield to the (S) terminal on each Nexus® meter and to the Ground on the RS485 Master. This connection is used to reference the Nexus® meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
- Provide termination resistors at each end, connected to the (+) and (-) lines. RT is approximately 120 Ohms, but this value may vary based on length of cable run, gauge or the impedance of the wire. See RT EXPLANATION in Section 5.3 .

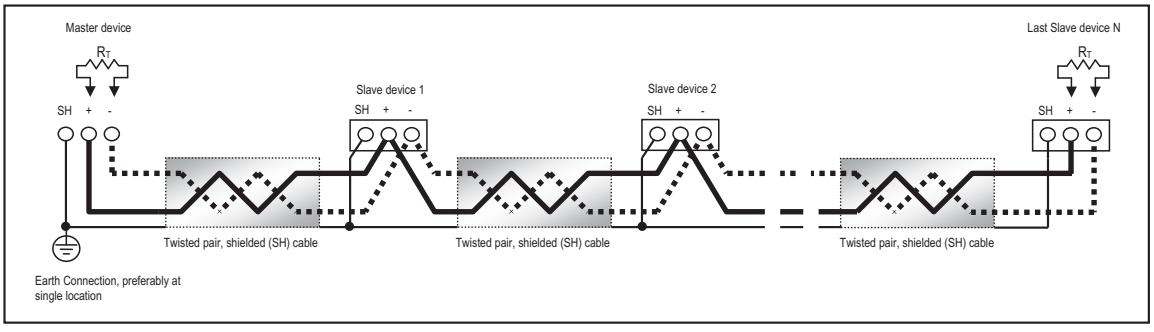


Figure 5.9: Linking Multiple Nexus® Meters in Series

You can use an RS485 repeater to network several links of instruments.

NOTES:

- A maximum number of 31 Nexus® meters may be connected to one repeater.
- A maximum number of 31 repeaters may be included on the same network.

5.8: Remote Communication Overview

Either RJ11 (INP2 Option) or RJ45 (INP200 Option) can connect devices at great distances. Section 5.1 gives an overview of these communication options. Chapter 10 explains the INP2 Internal Modem Option; Chapter 11 explains the INP200 Network Option.

You can use also use modems to connect devices. EIG recommends using RS485 wiring with a Modem Manager. See Section 5.8.2 for additional information.

5.8.1: Remote Communication—RS232

The link using RS232 is viable for up to 50 feet (15.2 meters).

Set the selector switch under Port 1 to RS232.

Use an RS232 serial extension cable connected to the 9-pin female serial port of the Nexus® 1250/1252 meter's Port 1. Program this port for Modbus ASCII. See Chapter 3 of the *Communicator EXT User Manual* for details.

- You must use a Null Modem or Null Cable between the Nexus® meter and the remote modem when using RS232. A Null Modem enables two DCE devices to communicate. The figure below details how a null modem reconfigures the RS232 pins.

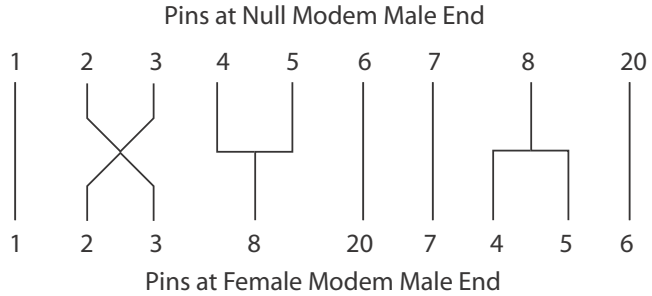


Figure 5.10: Standard Null Modem Configuration

NOTE: Connecting the Nexus® meter to a modem via RS485 protocol with EIG's Modem Manager converter eliminates the need for a Null Modem (see Section 5.8.2).

- The remote modem must be programmed for auto-answer and set at a fixed baud rate of 9600 with no Flow Control. See Section 5.8.3 and the *Communicator EXT User Manual* for further details.

5.8.2: Remote Communication-RS485

Use any Port on the Nexus® 1250/1252 meter. If you use Port 1, set the selector switch beneath the port to RS485. The link using RS485 is viable for up to 4000 feet (1219 meters).

Use Communicator EXT software to set the port's baud rate to 9600 and enable Modbus ASCII protocol. See Chapter 3 of the *Communicator EXT User Manual* for instructions. Remember, Modbus RTU will not function properly with modem communication. You **must** change the protocol to Modbus ASCII.

You must use an RS485 to RS232 converter and a Null Modem. EIG recommends using its Modem Manager, a sophisticated RS232/RS485 converter that enables devices with different baud rates to communicate. It also eliminates the need for a Null modem and automatically programs the modem to the proper configuration. Also, if the telephone lines are poor, Modem Manager acts as a line buffer, making the communication more reliable.

5.8.3: Programming Modems for Remote Communication

You must program a modem before it can communicate properly with most RS485 or RS232-based devices. This task is often quite complicated because modems can be unpredictable when communicating with remote devices.

If you are not using the EIG Modem Manager device, you must set the following strings to communicate with the remote Nexus® meter(s). Consult your modem's manual for the proper string settings or see Section 5.8.3.1 for a list of selected modem strings.

NOTE: Use a Modem Manager! The product was designed to make this task "plug and play." We highly recommend it for all serial modem solutions.

Modem Connected to a Computer (the Originate Modem)

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to display Result Codes. The computer will use the result codes.
- Set modem to Verbal Result Codes. The computer will use the verbal result codes.
- Set modem to use DTR Signal. This is necessary for the computer to ensure connection with the originate modem.
- Set modem to enable Flow Control. This is necessary to communicate with remote modem connected to the Nexus® meter.
- Instruct modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.

Modem Connected to the Nexus® Meter (the Remote Modem)

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to auto answer on n rings. This sets the remote modem to answer the call after *n* rings.
- Set modem to ignore DTR Signal. This is necessary for the Nexus® meter, to insure connection with originate modem.
- Set modem to disable Flow Control. The Nexus® meter's RS232 communication does not support this feature.
- Instruct modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.
- When programming the remote modem with a terminal program, make sure the baud rate of the terminal program matches the Nexus® meter's baud rate.

5.8.3.1: Selected Modem Strings

Modem	String / Setting
Cardinal modem	AT&FE0F8&K0N0S37=9
Zoom/Faxmodem VFX V.32BIS(14.4K)	AT&F0&K0S0=1&W0&Y0
Zoom/Faxmodem 56Kx Dual Mode	AT&F0&K0&C0S0=1&W0&Y0
USRobotics Sportster 33.6 Faxmodem: DIP switch setting	AT&F0&N6&W0Y0 (for 9600 baud) Up Up Down Down Up Up Up Down
USRobotics Sportster 56K Faxmodem: DIP switch setting	AT&F0&W0Y0 Up Up Down Down Up Up Up Down

5.9: High Speed Inputs Connection

The Nexus® 1250/1252 meter's built-in High Speed Inputs can be used in many ways:

- Attach the KYZ HS Outputs from other meters for totalizing.
- Attach relaying contacts for breaker status or initiated logging.
- Set as an Input Trigger for Historical Log 2.

Refer to the *Communicator EXT User Manual* for instructions on programming these features.

The High Speed Inputs can be used with either dry or wet field contacts. For Wet contacts, the common rides on a unit-generated Nominal 15V DC. No user programming is necessary to use either wet or dry field contacts.

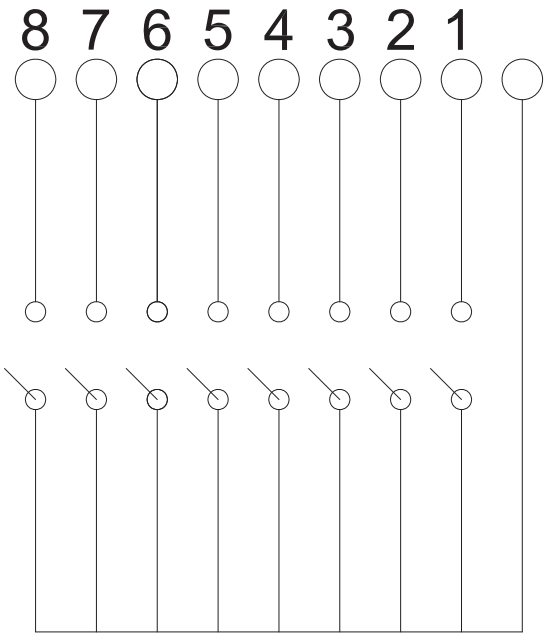


Figure 5.11: High-Speed Inputs Connections

5.10: IRIG-B Connections

IRIG-B is a standard time code format that synchronizes event time-stamping to within 1 millisecond. An IRIG-B signal-generating device connected to the GPS satellite system synchronizes Nexus® 1250/1252 meters located at different geographic locations. Nexus® meters use an un-modulated signal from a satellite-controlled clock (such as Arbiter 1093B). For details on installation, refer to the User's Manual for the satellite-controlled clock in use. Below are installation steps and tips that will help you.

Connection

Connect the (+) terminal of the Nexus® meter to the (+) terminal of the signal generating device; connect the (-) terminal of the Nexus® meter to the (-) terminal of the signal generating device.

Installation

Set Time Settings for the meter being installed.

1. From the Communicator EXT Device Profile menu:
   a. Click **General Settings>Time Settings>one of the Time Settings lines**, to open the Time Settings screen.
   b. Set the Time Zone and Daylight Savings (Select **AutoDST** or **Enable** and set dates).
   c. Click **Update Device Profile** to save the new settings. (See Chapter 3 of the *Communicator EXT User's Manual* for details.)
2. Before connection, check that the date on the meter clock is correct (or, within 2 Months of the actual date). This provides the right year for the clock (GPS does not supply the year).
3. Connect the (+) terminal of the Nexus® meter to the (+) terminal of the signal generating device; connect the (-) terminal of the Nexus® meter to the (-) terminal of the signal generating device.

Troubleshooting Tip: The most common source of problems is a reversal of the two wires. If you have a problem, try reversing the wires.

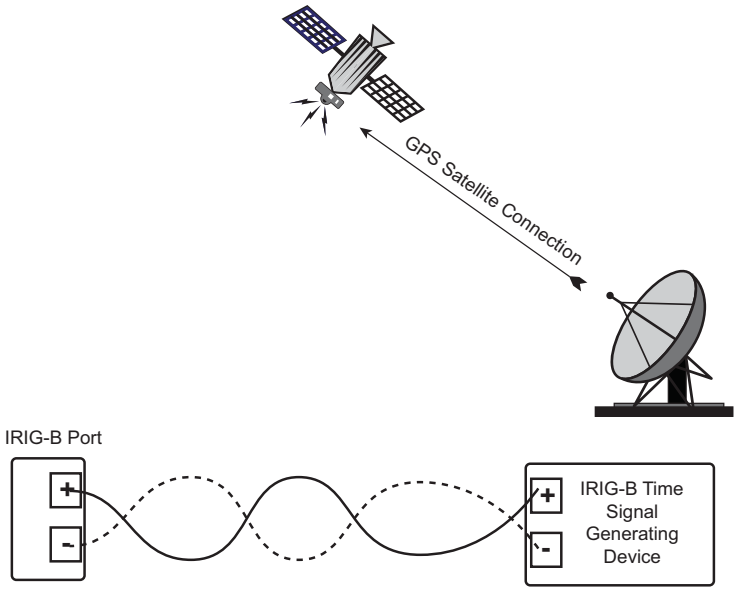


Figure 5.12: IRIG-B Communication

NOTE: Please make sure that the selected clock can drive the amount of wired loads.

5.11: Time Synchronization Alternatives

(See the *Communicator EXT User Manual* for details.)

IRIG-B

- All Nexus® 1250/1252 meters are equipped to use IRIG-B for time synchronization.
- If IRIG-B is connected, this form of time synchronization takes precedence over the internal clock. If the GPS Signal is lost, the internal clock takes over time keeping at the precise moment the signal is lost.

Line Frequency Clock Synchronization

- All Nexus® meters are equipped with Line Frequency Clock Synchronization, which may be enabled or disabled for use instead of IRIG-B. If Line Frequency Clock Synchronization is enabled and power is lost, the internal clock takes over at the precise moment power is lost.

Internal Clock Crystal

- All Nexus® meters are equipped with internal clock crystals which are accurate to 20ppm, and which can be used if IRIG-B is not connected and/or Line Frequency Clock Synchronization is not enabled.

DNP Time Synchronization

- Using Communicator EXT, you can set the meter to request time synchronization from the DNP Master. Requests can be made from once per minute to once per day. See the *Nexus® 1252/1262/1272/1500 DNP User Manual* for instructions. You can download the manual from EIG's website: www.electroind.com/pdf/DNPv3.0_Level2.pdf.

Other Time Setting Tools

- **Tools>Set Device Time**: For manual or PC time setting
- **Script & Scheduler**: Time stamps retrieved logs and data

- **MV90**: Can synchronize time on retrievals in the form of a Time Stamp. Refer to the *Communicator EXT User Manual* (HHF Converter) for more MV-90 details.

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6: Using the External Displays

This chapter provides information on the Nexus® 1250/1252 meter's external displays.

6.1: Overview

Electro Industries offers three external displays for use with the Nexus® 1250/1252 meter. The P40N+ (and legacy P40N), P41N+, and P43N+ are LED displays that provide easy-to-use access to the information stored in your Nexus® meter. The P40N+ display also features a USB port for direct data download.

Plug one of the Nexus® external displays into Port 3 or 4 of the meter, using the cable supplied with the display. The displays operate at 9600 baud. Port 3 is already factory-set to 9600 baud (see Chapter 5 for communication details). To use a display on another port, configure that port to operate at 9600 baud with the Communicator EXT Software. See Chapter 3 of the *Communicator EXT User Manual* for instructions on configuring the meter's port.

6.2: Nexus® P40N/P40N+, P41N+ and P43N+ LED External Displays

The Nexus® P40N and P40N+ LED external display can be used alone or as the Master for a grouping of displays. The P40N/P40N+ prepares the data for the Slave displays: the P41N+ and the P43N+. Once every second, it sends a request to the Nexus® meter. All necessary data for the Slave displays is returned to the Master display upon this request, and the Master sends the data to the Slaves in the proper format.

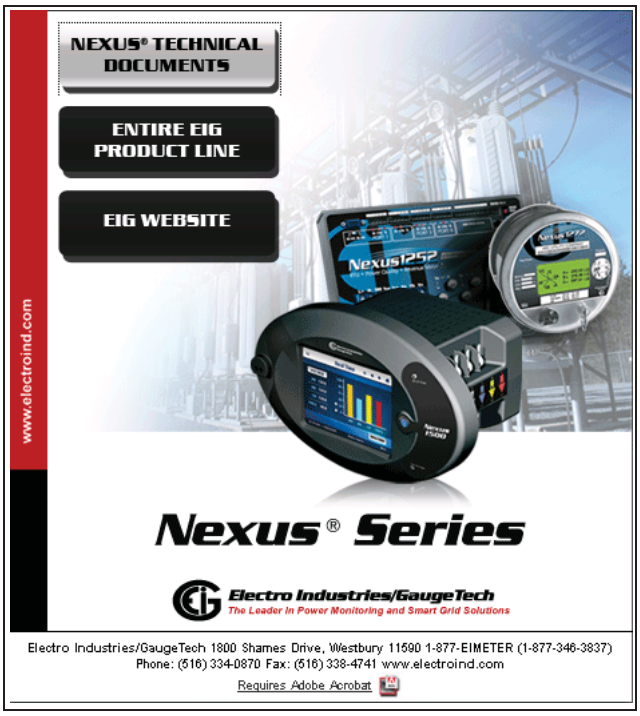
The Nexus® P41N+ and P43N+ Slave displays listen to the Master, and display and update values on the screen when they receive proper data. These displays have no keypads. Data can only be received; it cannot be changed. If there is no data for more than 5 seconds, "Communication Lost" appears on the bottom of the screen. The following data is displayed when it is received:

- Amp Display (P41N+): Amp A, Amp B, Amp C
- Power Display (P43N+): Watt, VAR, PF

The Nexus® P40N+ LED external display has a USB port on the front for direct data downloads. You can connect to the USB port with Communicator EXT to poll and configure the meter attached to the display. To use the USB, follow these instructions:

1. Use the Nexus® Series Product CD, shipped with your meter, to install the Communicator EXT software and the driver for the P40N+ USB port.

   a. Insert the CD into your PC's CD drive. The screen shown below opens in your Browser.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Phone: (516) 334-0870 Fax: (516) 338-4741 www.electroind.com
Requires Adobe Acrobat

   b. Click the **Nexus® Series Technical Documents** button. The following screen opens in your Browser.

c. To install Communicator EXT 3.0 software and the driver for the P40N+:

i. Click on the **Communicator EXT 3.0** button and click **Run**. The software is installed.

ii. Click on the **USB Driver** button click **Run**. The P40N+ driver is installed.

2. Connect the USB cable from your PC to the port: using a USA-A Male to USB-B Male cable, attach the USB-A connector to the PC and attach the USB-B connector to the P40N+ USB port. See Figure 6.1.

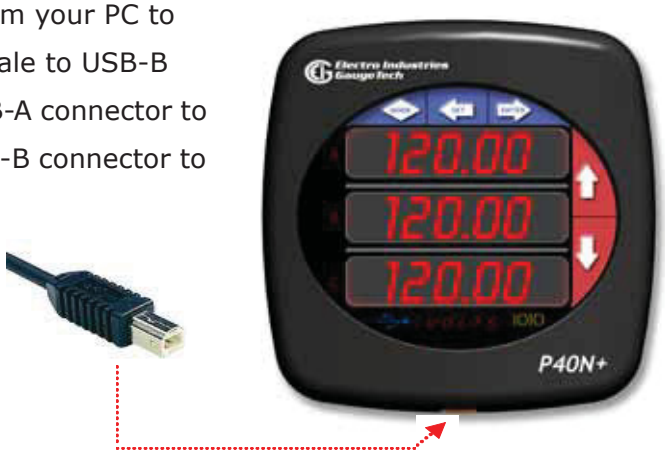


Figure 6.1: USB-B Male Connector and P40N+ USB Port

3. Once the USB cable is connected to the P40N+, the display clears and the message "USB in Use" scrolls at the bottom of the display. Additionally, the USB LED icon lights up when the USB connection is being used.

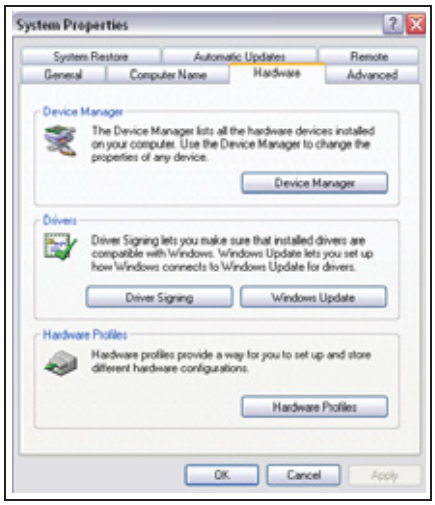
You connect to the USB port using Communicator EXT software the same way you connect to a meter with the software. Follow these instructions:

1. Determine which port the PC's USB is using:

   a. On your PC, click **Start>Settings>Control Panel**.

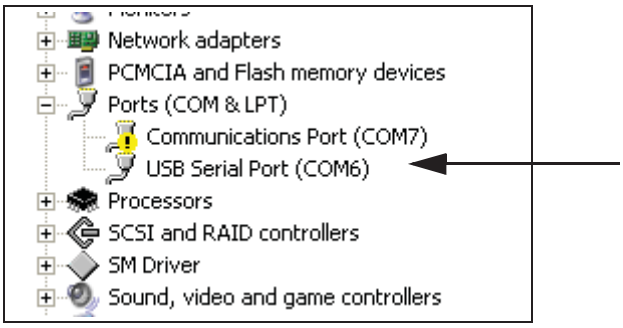
   b. Double-click the **System** folder.

   c. Click the **Hardware** tab. You will see the screen below.

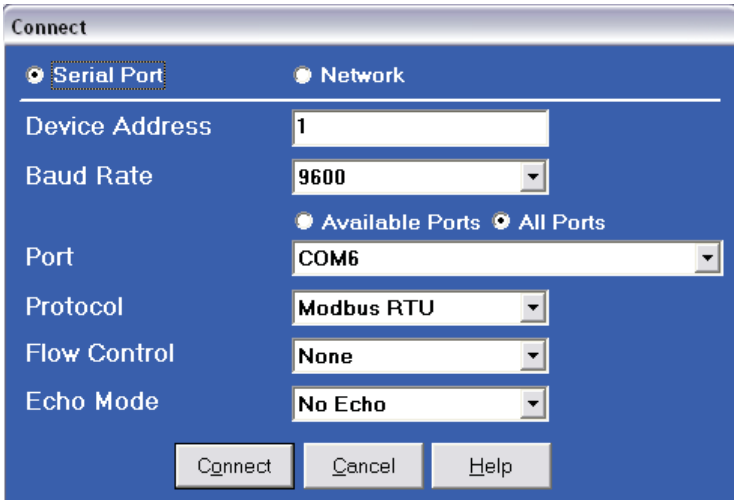

System Properties
System Restore
Automatic Updates
Remote
General
Computer Name
Hardware
Advanced
Device Manager
The Device Manager lists all the hardware devices installed on your computer. Use the Device Manager to change the properties of any device.
Device Manager
Drivers
Driver Signing lets you make sure that installed drivers are compatible with Windows. Windows Update lets you set up how Windows connects to Windows Update for drivers.
Driver Signing
Windows Update
Hardware Profiles
Hardware profiles provide a way for you to set up and store different hardware configurations.
Hardware Profiles
OK
Cancel
Apply

   d. Click the **Device Manager** button. You will see a list of the computer's hardware devices.

e. Click the plus sign next to Ports (COM & LPT). The COM ports are displayed. Note the COM number for the USB Serial Port. This is the number you will use to connect to the P40N+ through Communicator EXT. See the figure below.



2. Open Communicator EXT software and click the **Connect** icon in the Icon bar. See the screen shown below.



3. Click the **Serial Port** button if it's not already selected.

4. Set the Baud Rate to 9600. (It uses 9600 because it shares an existing Com port for displayed readings.)

5. Click the **Available Ports** button and select the USB COM Port number from the drop-down list.

6. Protocol should be Modbus RTU.

7. Flow Control should be None.

8. Echo Mode should be No Echo.

9. Click **Connect**. The software connects to the meter through the P40N+. Refer to the *Communicator EXT User's Manual* for programming instructions. (Click **Help>Contents** from the Communicator EXT Title Bar to view the manual online.)

6.2.1: Connect Multiple Displays

One cable (housing two-wire RS485 and two-wire power wires plus shield) is used to connect the displays. The Nexus® meter's ports support 12 VA. Each P40N/P40N+, P41N+ or P43N+ requires 3.3 VA (maximum 3.8 VA). The Master display (P40N+) is the master in communication. The Amp, Power and Nexus® devices are slaves in communication. Therefore, the Master display (P40N+) should be at the end of the daisy-chained units as shown in Figure 6.2.

Figure 6.2: Daisy Chaining Displays

6.2.2: Nexus® P40N/P40N+ Display Modes

The Nexus® P40N/P40N+ LED external display has three modes:

- Dynamic Readings mode (sections 6.3 and 6.4)
- Nexus® Information mode (sections 6.5 and 6.6)
- Display Features mode (sections 6.7 and 6.8)

Each mode is divided into groups. Most groups are further broken down into readings.

- Use the MODE button to scroll between modes.

- Use the UP/DOWN arrows to scroll from group to group within each mode.
- Use the LEFT/RIGHT arrows to scroll from reading to reading within each group.

Use the Communicator EXT software to Flash Update the P40N/P40N+ external display. Refer to the *Communicator EXT User Manual* for instructions.

6.3: Dynamic Readings Mode

The External Display puts itself in the Dynamic Readings Mode upon power-up. Use the Mode button to access the Dynamic Readings from other Modes. Use the Up/Down arrows to navigate from Group to Group within this Mode. See Section 6.4 for a Navigation map of the Dynamic Readings Mode.

Group 1: Phase to Neutral Voltages (Use the Left/Right arrows to access the following readings, in order.)

- Volts AN/BN/CN
- Maximum Volts AN/BN/CN
- Minimum Volts AN/BN/CN
- Volts AN/BN/CN %THD
- Volts AN/BN/CN Maximum %THD
- Volts AN/BN/CN Minimum %THD

Group 2: Phase to Phase Voltages (Use the Left/Right arrows to access the following readings, in order.)

- Volts AB/BC/CA
- Minimum Volts AB/BC/CA
- Maximum Volts AB/BC/CA

Group 3: Current (Use the Left/Right arrows to access the following readings, in order.)

- Current A/B/C

- Maximum Current
- Minimum Current
- Current %THD
- Current Maximum %THD
- Current Minimum %THD
- Current Calculated N/Measured N
- Maximum Current Calculated N/Measured N

Group 4: Watt / VAR (Use the Left/Right arrows to access the following readings, in order.)

- kWatt/kVAR
- Maximum +kWatt/+kVAR/CoIn kVAR
- Maximum -kWatt/-kVAR/CoIn kVAR
- Block (Fixed) Window Average Maximum +kWatt/+kVAR/CoIn kVAR
- Predictive Rolling (Sliding) Window Maximum +kWatt/+kVAR/CoIn kVAR

Group 5:VA / PF / Frequency (Use the Left/Right arrows to access the following readings, in order.)

- kVA/PF lag/Hz
- Maximum kVA/Hz
- Minimum kVA/Hz
- Maximum Quadrant 1 Total PF
- Minimum Quadrant 1 Total PF
- Maximum Quadrant 2 Total PF
- Minimum Quadrant 2 Total PF

- Maximum Quadrant 3 Total PF
- Minimum Quadrant 3 Total PF
- Maximum Quadrant 4 Total PF
- Minimum Quadrant 4 Total PF

Group 6: Delivered Energy (Use the Left/Right arrows to access the following readings, in order.)

- +kWatthr Quadrant 1+Quadrant 4 (Primary)
- +kVAhr Quadrant 1 (Primary)
- +kVARhr Quadrant 1 (Primary)
- +kVAhr Quadrant 4 (Primary)
- -kVARhr Quadrant 4 (Primary)

Group 7: Received Energy (Use the Left/Right arrows to access the following readings, in order.)

- -kWatthr Quadrant 2+Quadrant 3 (Primary)
- +kVAhr Quadrant 2 (Primary)
- +kVARhr Quadrant 2 (Primary)
- +kVAhr Quadrant 3 (Primary)
- -kVARhr Quadrant 3 (Primary)

Group 8: Accumulations (Use the Left/Right arrows to access the following readings, in order.)

- kI2t A
- kI2t B
- kI2t C

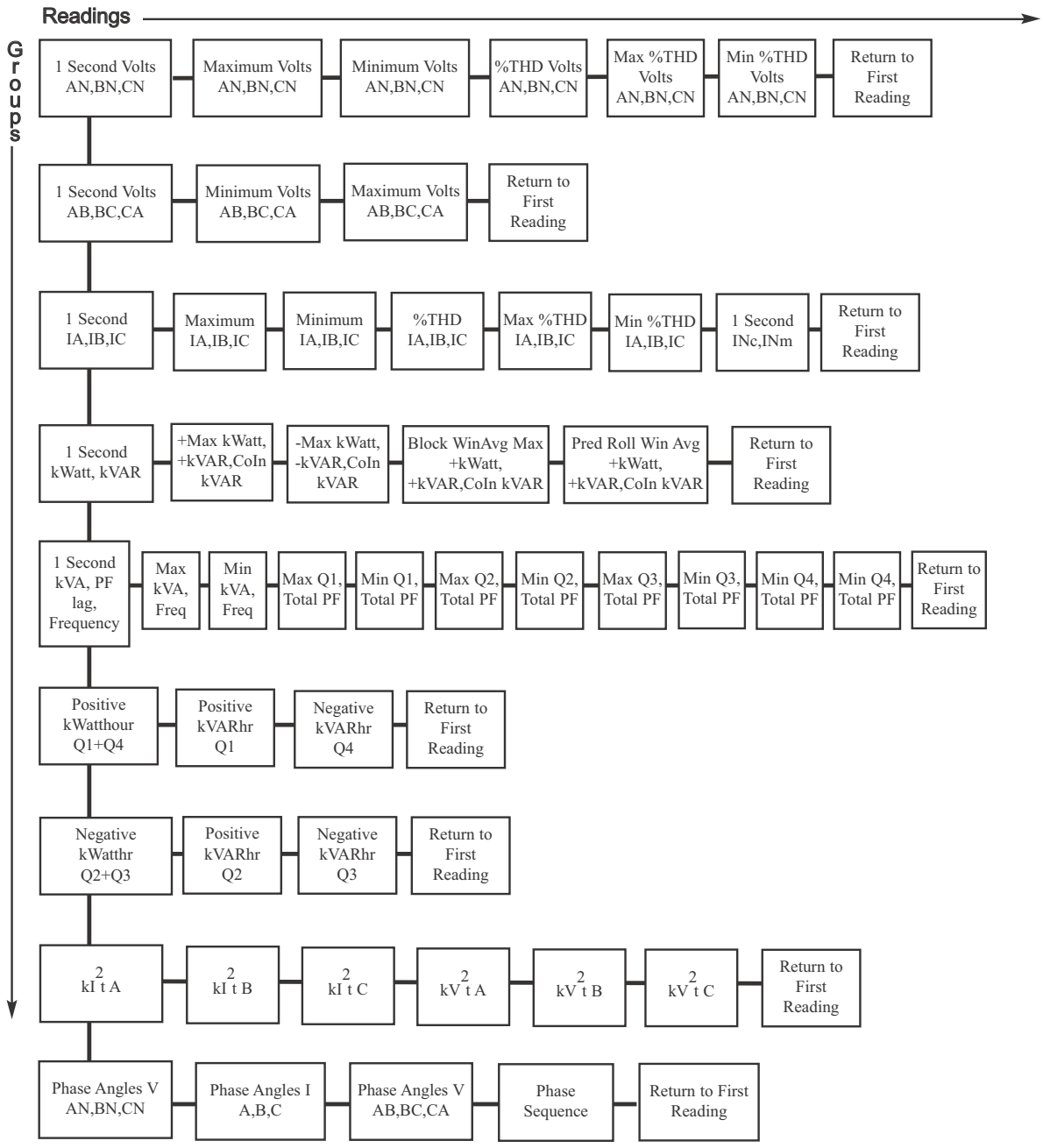
- kV2t A
- kV2t B
- kV2t C

Group 9: Phase Angles (Use the Left/Right arrows to access the following readings, in order.)

- Phase Angle Van/bn/cn
- Phase Angle Ia/b/c
- Phase Angle Vab/bc/ca
- Phase Sequence

6.4: Navigation Map of Dynamic Readings Mode

- Use Left/Right arrow keys to navigate Readings
- Use Up/Down arrows to scroll between groups.



6.5: Nexus® Information Mode

Use the Mode button to access the Nexus® Information mode from other modes. Use the Up/Down arrows to navigate from group to group within this mode. See Section 6.6 for a Navigation map of the Nexus® Information Mode.

Group 1: Device Time

Meter Time

Group 2: Communication Settings (Use the Left/Right arrows to access the following readings, in order.)

- Communication Settings Port 1: Baud/Addr/Protocol
- Communication Settings Port 2: Baud/Addr/Protocol
- Communication Settings Port 3: Baud/Addr/Protocol
- Communication Settings Port 4: Baud/Addr/Protocol

Group 3: PT/CT Ratios (Use the Left/Right arrows to access the following readings, in order.)

- PT Ratio
- CT Ratio

Group 4: External Display Units

Primary/Secondary:

Select either Primary or Secondary units for the External Display using the Communicator EXT software (see the *Communicator EXT User Manual*).

- When Primary is selected, the Display shows all readings in Primary units based on the user programmed PT and CT Ratios.
- When Secondary is selected, the Display shows all readings in Secondary units.

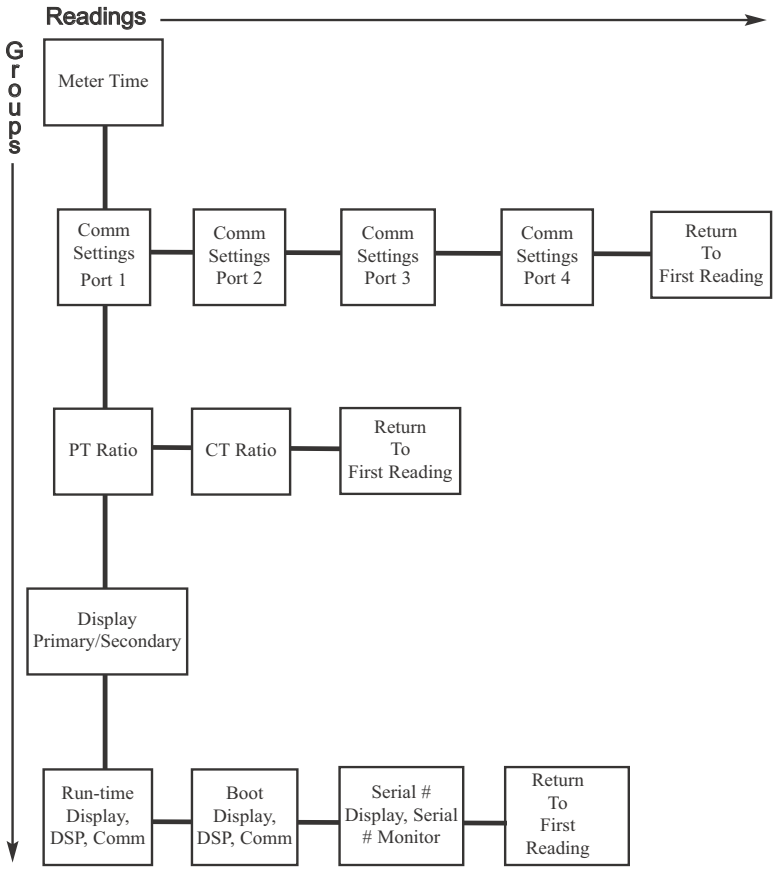
Group 5: Firmware Versions and Serial Numbers (Use the Left/Right arrows to access the following readings, in order.)

- Run Time External Display/Run Time DSP/RunTime Comm
- Boot External Display/Boot DSP/Boot Comm
- Serial Number External Display; Serial Number Nexus® Monitor

6.6: Navigation Map of Nexus® Information Mode

- Use Left/Right arrow keys to navigate Readings

Use Up/Down arrows to scroll between groups.



6.7: Display Features Mode

Use the Mode button to access the Display Features Mode from other modes. Use the Up/Down arrows to navigate from group to group within this mode. See Section 6.8 for a Navigation map of the Display Features mode.

Group 1: Reset Max/Min

Press **Enter** to reset the Max and Min values.

NOTE: If the Password Protection feature has been enabled through Communicator EXT software, you will need to enter a password to reset the Max/Min readings. Follow this procedure:

1. Press **Enter**.
2. Enter the password, one character at a time, by pressing the Up or Down arrows. (Each password character begins as an "A". Press the Up arrow to increment the character from "A-Z" and then from "0-9". Press the Down arrow to decrement the character from "A" to "9-0" and then from "Z-A".)
3. Press **Set** to enter each character in the password.
4. When the entire password is shown on the Display screen, press **Enter**.
5. Once the password is entered correctly, press **Enter** again to reset the Max/Min values.

Group 2: Reset Energy

Press **Enter** to reset the Energy readings.

NOTE: If the Password Protection feature has been enabled through Communicator EXT software, you will need to enter a password to reset the Energy readings. Follow steps 1-4, above. Then press **Enter** again to reset energy.

Group 3: Display Baud Rate/Address

Group 4: Display Communication Protocol

Group 7: Lamp Test

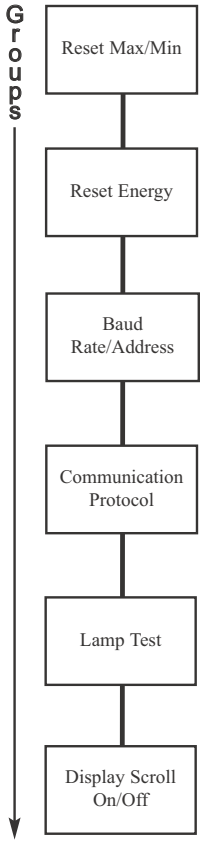
Press **Enter** to conduct an LED test.

Group 8: Display Scroll ON/OFF

Press **Enter** to turn the scroll feature on or off. When the scroll feature is on, the P40N+ external display scrolls through the first reading of each group in the Dynamic Readings mode. If a button is pressed during the scroll, scrolling pauses for one minute.

6.8: Navigation Map of Display Features Mode

Use Up/Down arrows to scroll between groups.



7: Transformer Loss Compensation

7.1: Introduction

The Edison Electric Institute's Handbook for Electricity Metering, Ninth Edition defines Loss Compensation as:

A means for correcting the reading of a meter when the metering point and point of service are physically separated, resulting in measurable losses including I2R losses in conductors and transformers and iron-core losses. These losses may be added to or subtracted from the meter registration.

Loss compensation may be used in any instance where the physical location of the meter does not match the electrical location where change of ownership occurs. Most often this appears when meters are connected on the low voltage side of power transformers when the actual ownership change occurs on the high side of the transformer. This condition is shown pictorially in Figure 7.1.

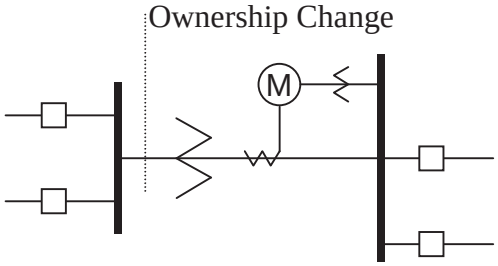


Figure 7.1: Low Voltage Metering Installation Requiring Loss Compensation

It is generally less expensive to install metering equipment on the low voltage side of a transformer and in some conditions other limitations may also impose the requirement of low-side metering even though the actual ownership change occurs on the high-voltage side.

The need for loss compensated metering may also exist when the ownership changes several miles along a transmission line where it is simply impractical to install metering equipment. Ownership may change at the midway point of a transmission line where there are no substation facilities. In this case, power metering must again be compensated. This condition is shown in Figure 7.2.

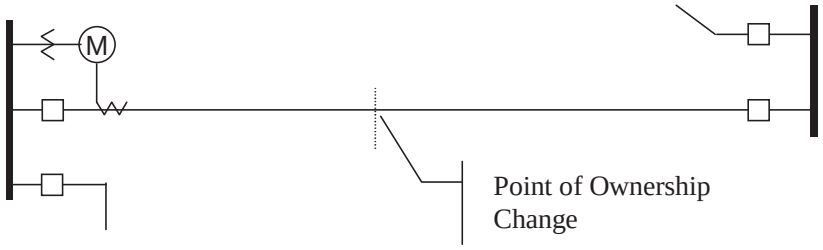


Figure 7.2: Joint Ownership Line Meeting Requiring Loss Compensation

A single meter cannot measure the losses in a transformer or transmission line directly. It can, however, include computational corrections to calculate the losses and add or subtract those losses to the power flow measured at the meter location. This is the method used for loss compensation in the Nexus® meter. Refer to Appendix B of the Communicator EXT User Manual for detailed explanation and instructions for using the Transformer Line Loss Compensation feature of the Nexus® 1250/1252 meter.

The computational corrections used for transformer and transmission line loss compensation are similar. In both cases, no-load losses and full-load losses are evaluated and a correction factor for each loss level is calculated. However, the calculation of the correction factors that must be programmed into the meter differ for the two different applications. For this reason, the two methodologies will be treated separately in this chapter.

In the Nexus® meter, Loss Compensation is a technique that computationally accounts for active and reactive power losses. The meter calculations are based on the formulas below. These equations describe the amount of active (Watts) and reactive (VARs) power lost due to both iron and copper effects (reflected to the secondary of the instrument transformers).

Total Secondary Watt Loss =

(((Measured Voltage/Cal point Voltage)2 x %LWFE) + ((Measured Current/Cal Point Current)2 x %LWCU)) x Full-scale Secondary VA

Total Secondary VAR Loss =

(((Measured Voltage/Cal point Voltage)4 x %LVFE) + ((Measured Current/Cal Point Current)2 x %LVCU)) x Full-scale Secondary VA

The Values for %LWFE, %LWCU, %LVFE, and %LVCU are derived from the transformer and meter information, as demonstrated in the following sections.

The calculated loss compensation values are added to or subtracted from the measured Watts and VARs. The selection of adding or subtracting losses is made through the meter's profile when programming the meter (see the following section for instructions). The meter uses the combination of the add/subtract setting and the directional definition of power flow (also in the profile) to determine how to handle the losses. Losses will be "added to" or "subtracted from" (depending on whether add or subtract is selected) the Received Power flow. For example, if losses are set to "Add to" and received power equals 2000 kW and losses are equal to 20kW then the total metered value with loss compensation would be 2020 kW; for these same settings if the meter measured 2000 kW of delivered power the total metered value with loss compensation would be 1980 kW.

Since transformer loss compensation is the more common loss compensation method, the meter has been designed for this application. Line loss compensation is calculated in the meter using the same terms but the percent values are calculated by a different methodology.

Nexus® Meter Transformer Loss Compensation:

- Performs calculations on each phase of the meter for every measurement taken. Unbalanced loads are accurately handled.
- Calculates numerically, eliminating the environmental effects that cause inaccuracies in electromechanical compensators.
- Performs Bidirectional Loss Compensation.
- Requires no additional wiring; the compensation occurs internally.
- Imposes no additional electrical burden when performing Loss Compensation.

Loss Compensation is applied to 1 second per phase Watt/VAR readings and, because of that, affects all subsequent readings based on 1 second per phase Watt/VAR readings. This method results in loss compensation being applied to the following quantities:

- Total Power
- Demands, per Phase and Total (Thermal, Block (Fixed) Window, Rolling (Sliding) Window and Predictive Window)
- Maximum and Minimum Demands
- Energy Accumulations
- KYZ Output of Energy Accumulations

NOTE: Loss Compensation is disabled when the meter is placed in Test Mode.

7.2: Nexus® 1250 / 1252 Meter's Transformer Loss Compensation

The Nexus® meter provides compensation for active and reactive power quantities by performing numerical calculations. The factors used in these calculations are derived either:

- By clicking the TLC Calculator button on the Transformer Loss screen of the Device Profile, to open the EIG Loss Compensation Calculator in Microsoft Excel
- By figuring the values from the worksheet shown here and in Appendix B of the *Communicator EXT User Manual*.

Either way, you enter the derived values into the Communicator EXT software through the Device Profile Transformer and Line Loss Compensation screen.

The Communicator EXT software allows you to enable Transformer Loss Compensation for Losses due to Copper and Iron, individually or simultaneously. Losses can either be added to or subtracted from measured readings. Refer to Appendix B in the *Communicator EXT User Manual* for instructions.

Loss compensation values must be calculated based on the meter installation. As a result, transformer loss values must be normalized to the meter by converting the base voltage and current and taking into account the number of elements used in the

metering installation. For three-element meters, the installation must be normalized to the phase-to-neutral voltage and the phase current; in two-element meters the installation must be normalized to the phase-to-phase voltage and the phase current. This process is described in the following sections.

7.2.1: Loss Compensation in Three Element Installations

Loss compensation is based on the loss and impedance values provided on the transformer manufacturer's test report. A typical test report will include at least the following information:

- Manufacturer
- Unit Serial Number
- Transformer MVA Rating (Self-Cooled)
- Test Voltage
- No Load Loss Watts
- Load Loss Watts (or Full Load Loss Watts)
- % Exciting Current @ 100% voltage
- % Impedance

The transformer MVA rating is generally the lowest MVA rating (the self-cooled or OA rating) of the transformer winding. The test voltage is generally the nominal voltage of the secondary or low voltage winding. For three-phase transformers these values will typically be the three-phase rating and the phase-to-phase voltage. All of the test measurements are based on these two numbers. Part of the process of calculating the loss compensation percentages is converting the transformer loss values based on the transformer ratings to the base used by the meter.

Correct calculation of loss compensation also requires knowledge of the meter installation. In order to calculate the loss compensation settings you will need the following information regarding the meter and the installation:

- Number of meter elements

- Potential Transformer Ratio (PTR)
- Current Transformer Ratio (CTR)
- Meter Base Voltage
- Meter Base Current

This section is limited to application of Nexus® meters to three-element metering installations. As a result, we know that:

- Number of metering elements = 3
- Meter Base Voltage = 120 Volts
- Meter Base Current = 5 Amps

7.2.1.1: Three-Element Loss Compensation Worksheet

Company		Station Name	
Date		Trf. Bank No.	
Trf Manf		Trf Serial No.	
Calculation by			

Transformer Data (from Transformer Manufacturer's Test Sheet)

Winding	Voltage	MVA	Connection
HV - High			Δ-Y
XV - Low			Δ-Y
YV - Tertiary			Δ-Y

Value	Watts Loss		
	3-Phase	1-Phase	1-Phase kW
No-Load Loss			
Load Loss			

Enter 3-Phase or 1-Phase values. If 3-Phase values are entered, calculate 1-Phase values by dividing 3-Phase values by three. Convert 1-Phase Loss Watts to 1-Phase kW by dividing 1-Phase Loss Watts by 1000.

Value	3-Phase MVA	1-Phase MVA	1-Phase kVA
Self-Cooled Rating			

Enter 3-Phase or 1-Phase values. If 3-Phase values are entered, calculate 1-Phase values by dividing 3-Phase values by three. Convert 1-Phase Self-Cooled MVA to 1-Phase kVA by multiplying by 1000.

% Exciting Current	
% Impedance	

Value	Phase-to-Phase	Phase-to-Neutral
Test Voltage (Volts)		
Full Load Current (Amps)		

Test Voltage is generally Phase-to-Phase for three-phase transformers. Calculate Phase-to-Neutral Voltage by dividing Phase-to-Phase Voltage by the square root of 3. Calculate Full Load Current by dividing the (1-Phase kW Self-Cooled Rating) by the (Phase-to-Neutral Voltage) and multiplying by 1000.

Meter / Installation Data

Instrument Transformers	Numerator	Denominator	Multiplier
Potential Transformers			
Current Transformers			
Power Multiplier [(PT Multiplier) x (CT Multiplier)]			

Enter the Numerator and Denominator for each instrument transformer. For example, a PT with a ratio of 7200/120 has a numerator or 7200, a denominator or 120 and a multiplier of 60 (7200/120 = 60/1).

Meter Secondary Voltage (Volts)	120
Meter Secondary Current (Amps)	5

Base Conversion Factors

Quantity	Trans-former	Multiplier	Trf IT Sec	Meter Base	Meter/Trf
Voltage				120	
Current				5	

For Transformer Voltage, enter the Phase-to-Neutral value of Test Voltage previously calculated. For Transformer Current, enter the Full-Load Current previously calculated. For Multipliers, enter the PT and CT multipliers previously calculated.

TrfIT Secondary is the Base Value of Voltage and Current at the Instrument Transformer Secondary of the Power Transformer. These numbers are obtained by dividing the Transformer Voltage and Current by their respective Multipliers. The Meter/Trf values for Voltage and Current are obtained by dividing the Meter Base values by the TrfIT Secondary values.

Load Loss at Transformer

No-Load Loss Watts (kW) = 1-Phase kW No-Load Loss = _____

No-Load Loss VA (kVA) = (%Exciting Current) * (1-Phase kVA Self-Cooled Rating) / 100 = (_____) * (_____) / 100

= _____ kVA

No-Load Loss VAR (kVAR) = SQRT((No-Load Loss kVA)2 - (No-Load Loss kW)2) = SQRT((_____)2 - (_____)2)

= SQRT((_____) - (_____))

= SQRT (_____) = _____

Full-Load Loss Watts (kW) = 1-Phase Kw Load Loss = _____

Full-Load Loss VA (kVA) = (%Impedance) * (1-Phase kVA Self-Cooled Rating) / 100 = (_____) * (_____) / 100

= _____ kVA

Full-Load Loss VAR (kVAR) = SQRT((Full-Load Loss kVA)2 - (Full-Load Loss kW)2) = SQRT((_____)2 - (_____)2)

= SQRT((_____) - (_____))

= SQRT (_____) = _____

Normalize Losses to Meter Base

Quantity	Value at Trf Base	M/T Factor	M/T Factor Value	Exp	M/T Factor w/Exp	Value at Meter Base
No-Load Loss kW		V		^2		
No-Load Loss kVAR		V		^4		
Load Loss kW		1		^2		
Load Loss kVAR		1		^2		

Enter Value at Transformer Base for each quantity from calculations above. Enter Meter/Trf Factor value from Base Conversion Factor calculations above. Calculate M/T Factor with Exponent by raising the M/T Factor to the power indicated in the "Exp" (or Exponent) column.

Calculate the "Value at Meter Base" by multiplying the (M/T Factor w/ Exp) times the (Value at Trf Base).

Loss Watts Percentage Values

Meter Base kVA = 600 * (PT Multiplier) * (CT Multiplier) / 1000

= 600 * (_____) * (_____) / 1000

= _____

Calculate Load Loss Values

Quantity	Value at Meter Base	Meter Base kVA	% Loss at Meter Base	Quantity
No-Load Loss kW				% Loss Watts FE
No-Load Loss kVAR				% Loss VARs FE
Load Loss kW				% Loss Watts CU
Load Loss kVAR				% Loss VARs CU

Enter "Value at Meter Base" from Normalize Losses section. Enter "Meter Base kVA" from previous calculation. Calculate "% Loss at Meter Base" by dividing (Value at Meter Base) by (Meter Base kVA) and multiplying by 100.

Enter calculated % Loss Watts values into the Nexus® meter using Communicator EXT software. Refer to Appendix B of the *Communicator EXT User Manual* for instructions.

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8: Time-of-Use Function

8.1: Introduction

A Time-of-Use (TOU) usage structure takes into account the quantity of energy used and the time at which it was consumed. The Nexus® 1250/1252 meter's TOU function, available with the Communicator EXT software, is designed to accommodate a variety of programmable rate structures. The Nexus® meter's TOU function accumulates data based on the time-scheme programmed into the meter.

See Chapter 10 of the *Communicator EXT User Manual* for details on programming the Nexus® 1250/1252 meter's 20-year TOU calendar and retrieving TOU data.

8.2: The Nexus® Meter's TOU Calendar

A Nexus® TOU calendar sets the parameters for TOU data accumulation. You may store up to twenty calendars in the Nexus® 1250/1252 meter and an unlimited amount of calendar files on your computer.

The Nexus® TOU calendar profile allows you to assign a programmable usage schedule - e.g., "Weekday," "Weekend," or "Holiday"- to each day of the calendar year. You may create up to 16 different TOU schedules.

Each TOU schedule divides the 24-hour day into fifteen-minute intervals from 00:00:00 to 23:59:59. You may apply one of eight different programmable registers - e.g., "Peak," "Off Peak," or "Shoulder Peak," to each fifteen-minute interval.

The Nexus® 1250/1252 meter stores:

- Accumulations on a seasonal basis (up to four seasons per year)
- Accumulations on a monthly basis.

Seasonal and monthly accumulations may span from one year into the next. Each season and month is defined by a programmable start/billing date, which is also the end-date of the prior season or month.

A season ends at midnight of the day before the start of the next season.

A month ends at midnight of the month's billing day.

If the year ends and there is no new calendar, TOU accumulations stop. The last accumulation for the year ends on 12:31:23:59:59.

If a calendar is present for the following year, TOU accumulations continue until the next monthly bill date or next start-of-season is reached. Accumulation can span into the following year.

8.3: TOU Prior Season and Month

The Nexus® 1250/1252 meter stores accumulations for the prior season and the prior month. When the end of a billing period is reached, the current season or month becomes stored as the prior. The registers are then cleared and accumulations resume, using the next set of TOU schedules and register assignments from the stored calendar.

Prior and current accumulations to date are always available.

8.4: Updating, Retrieving and Replacing TOU Calendars

Communicator EXT software retrieves TOU calendars from the Nexus® meter or from the computer's hard drive for review and edit.

Up to a maximum of twenty yearly calendars can be stored in the Nexus® meter at any given time. You may retrieve them one at a time; a new calendar can be stored while a current calendar is in use.

Accumulations do not stop during calendar updates. If a calendar is replaced while in use, the accumulations for the current period will continue until the set end date. At that point, the current time will become the new start time and the settings of the new calendar will be used.

Reset the current accumulations, if you replace a calendar in use. A reset clears only the current accumulation registers. This causes the current accumulations to use the present date as the start and accumulate to the next new end date, which will be taken from the new calendar. Once stored, prior accumulations are always available and cannot be reset. See Chapter 3 of the *Communicator EXT User Manual* for instructions on resetting TOU accumulations.

At the end of a defined period, current accumulations are stored, the registers are cleared and accumulations for the next period begin. When the year boundary is

crossed, the second calendar, if present, is used. To retain continuity, you have up to one year to replace the old calendar with one for the following year.

8.5: Daylight Savings and Demand

To enable Daylight Savings Time for the meter: from the Device Profile menu click **General Settings>Time Settings**. In the Time Settings screen, click Auto DST, which sets Daylight Savings Time automatically (for the United States only). You can also select User Defined and enter the desired dates for Daylight Savings Time. See Chapter 3 of the *Communicator EXT User Manual* for instructions.

To set Demand intervals: from the Device Profile menu click **Revenue and Energy Settings>Demand Integration Intervals** and set the desired intervals. See Chapter 3 of the *Communicator EXT User Manual* for instructions.

To set Cumulative Demand Type, from the Device Profile menu click *Revenue and Energy Settings>Cumulative Demand Type* and select Block or Rolling Window Average. See Chapter 3 of the *Communicator EXT User Manual* for instructions.

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9: External I/O Modules

9.1: Hardware Overview

All Nexus® External I/O modules have the following components:

- Female RS485 Side Port: use to connect to another module's male RS485 side port.
- Male RS485 Side Port: use to connect to the Nexus® 1250/1252 Meter's Port 3 or 4 or to another module's female RS485 side port.
- I/O Port: used for functions specific to the type of module; size and pin configuration vary depending on type of module.
- Reset Button: Press and hold for three seconds to reset the module's baud rate to 57600 and its address to 247 for 30 seconds.
- LEDs: when flashing, signal that the module is functioning.
- Mounting Brackets (MBIO): used to secure one or more modules to a flat surface.

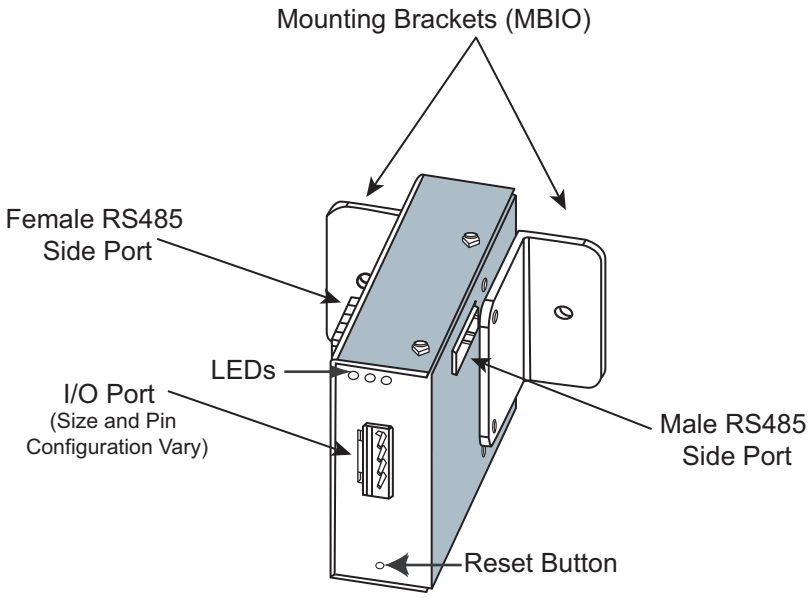
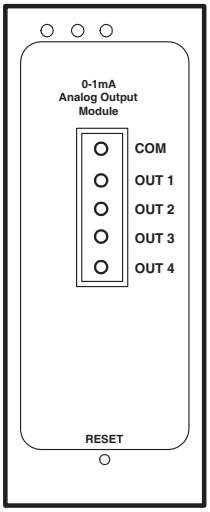


Figure 9.1: I/O Module Components

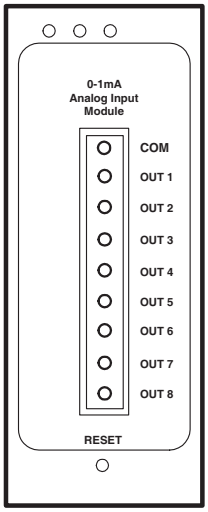
9.1.1: Port Overview

All Electro Industries I/O Modules have ports through which they interface with other devices. The port configurations are variations of the four types shown below.

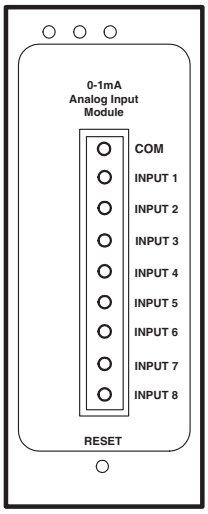
Four Analog Outputs (0-1mA and 4-20mA)



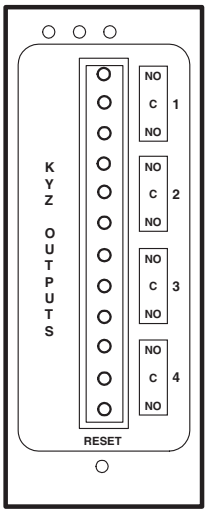
Eight Analog Outputs (0-1mA and 4-20mA)



Eight Analog Inputs (0-1mA, 0-20mA, 0-5Vdc, 0-10Vdc) or Eight Status Inputs



Four Relay Outputs or Four KYZ Pulse Outputs



9.2: I/O Module Installation

See sections 3.3 and 5.6 for installation instructions for the external I/O Modules.

9.2.1: Power Source for I/O Modules

The Nexus® 1250/1252 can supply power to a limited number of I/O Modules and external displays. For more modules, you must use an external power source, such as the EIG PSIO (12V). Refer to Section 5.6.2 to determine power needed.

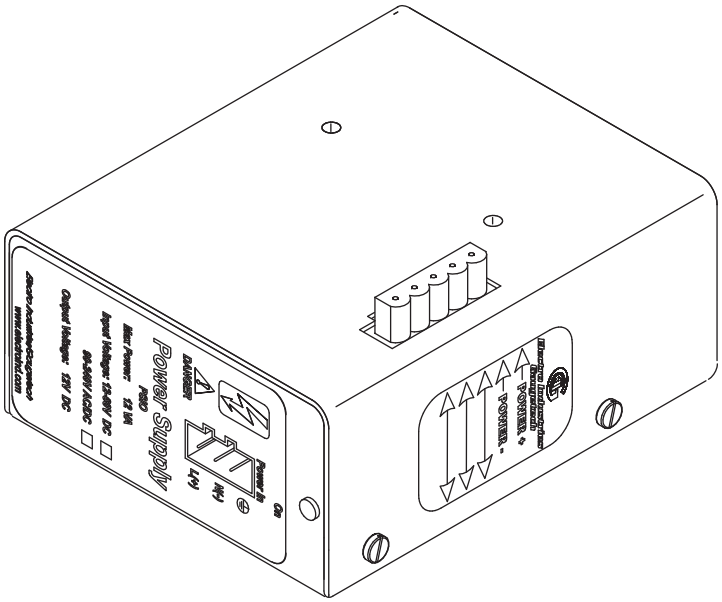


Figure 9.2: PSIO Power Supply Side View, Showing Male RS485 Port

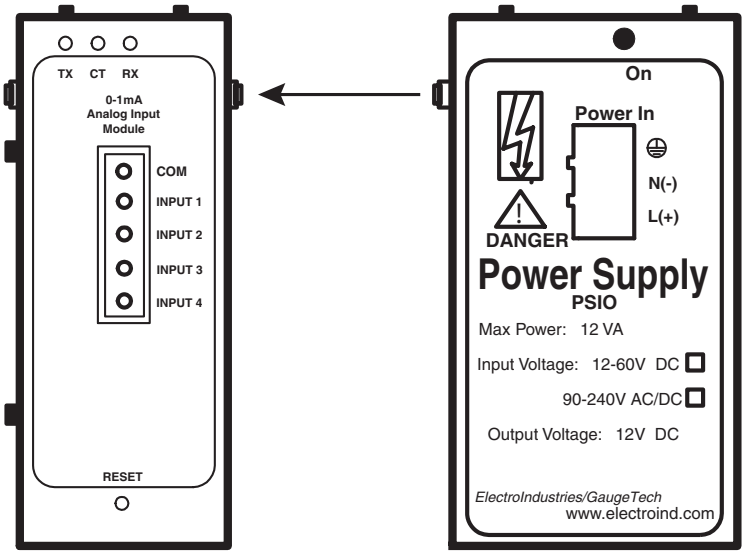


Figure 9.3: Power Flow from PSIO to I/O Module

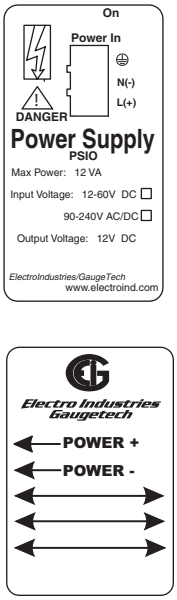


Figure 9.4: PSIO Side and Top Labels (Labels are Red and White)

9.3: Using the PSIO with Multiple I/O Modules

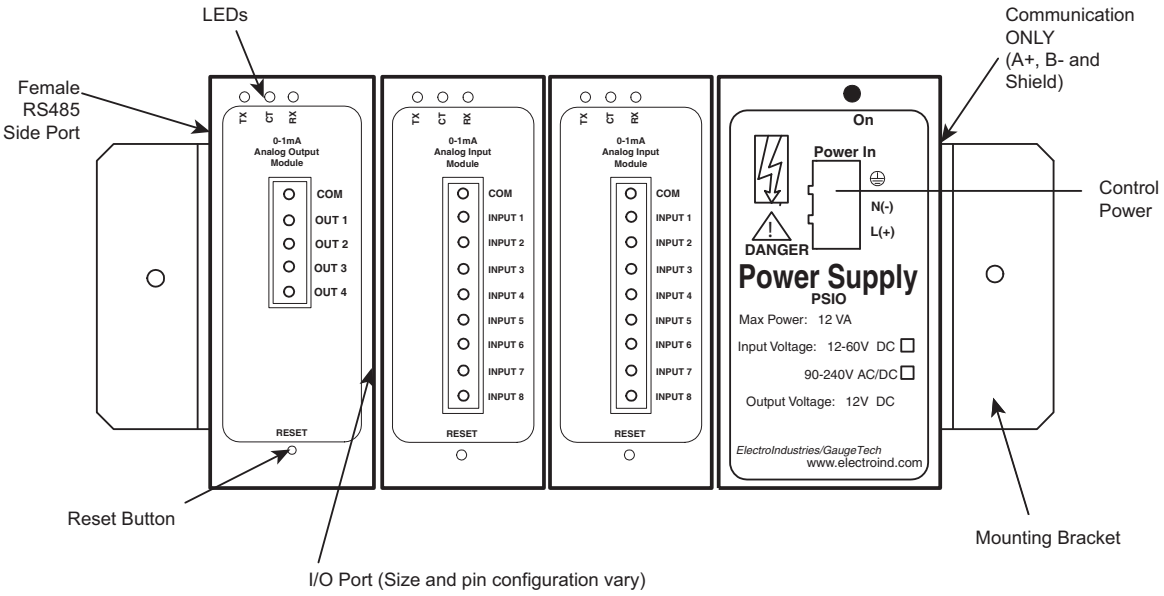


Figure 9.5: PSIO Used with Multiple I/O Modules

NOTE: As shown, the PSIO must be to the right of I/O Modules when viewing the front label.

9.3.1: Steps for Attaching Multiple I/O Modules

1. Each I/O module in a group must be assigned a unique address. See the *Communicator EXT User Manual* for details on configuring and programming the I/O Modules.

2. Determine how many power sources (such as the PSIO) are needed for the number of modules in use. See Section 5.6.2 for details.

3. Starting with the left module and using a slotted screwdriver, fasten the first I/O Module to the left Mounting Bracket. The left Mounting Bracket is the one with the PEM. Fasten the internal screw tightly into the left Mounting Bracket.

4. Next, slide the female RS485 port into the male RS485 side port to connect the next I/O module to the left module. Fasten together enough to grab, but do not tighten yet.

5. One by one combine the modules together.

6. If you require an additional power supply, attach a PSIO (power supply) to the right of the group of I/O Modules it is supplying with power.

NOTE: The PB1 can also be used for a Low Voltage Power Supply. It must be mounted separately.

7. Once you have combined all the I/O modules together for the group, fasten tightly. This final tightening will lock the whole group together as a unit.

8. Attach the right Mounting Bracket to the right side of the group using small phillips head screws provided.

9. Mount the group of modules on a secure, flat surface. This procedure will insure that all modules stay securely connected.

9.4: Factory Settings and Reset Button

Factory Settings:

All Nexus® I/O Modules are shipped with a preset address and a baud rate of 57600. See following sections for I/O Module addresses.

Reset Button:

If there is a communication problem or if you are unsure of a module's address and baud rate, press and hold the RESET button for 3 seconds; the module will reset to a default address of 247 at 57600 baud rate for 30-seconds. This enables you to interrogate the I/O using the Communicator EXT software; see the *Modbus Communicating I/O Modules User Manual*.

9.5: Analog Transducer Signal Output Modules

Analog Transducer Signal Output Module Specifications	
Model Numbers	1mAON4: 4-channel analog output 0±1mA
	1mAON8: 8-channel analog output 0±1mA
	20mAON4: 4-channel analog output 4-20mA
	20mAON8: 8-channel analog output 4-20mA
Accuracy	0.1% of Full Scale
Scaling	Programmable
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	15-20VDC @50-200mA; 1250/1252 supports up to two modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Maximum Load Impedance	0±1mA: 10k Ohms; 4-20mA: 500 Ohms
Factory Settings	Modbus Address: 1mAON4: 128; 1mAON8: 128; 20mAON4: 132; 20mAON8: 132
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20msec

9.5.1: Overview

The Analog Transducer Signal Output Modules (0±1mA or 4–20mA) are available in either a 4- or 8-channel configuration. Maximum registers per request, read or write, is 17 registers.

The Nexus® 1250/1252 meter supplies power for up to two connected Analog Output modules. See Section 9.2 for power and communication details. Refer to Section 5.6.2 to determine if you must use an additional power source, such as EIG's PSIO.

All outputs share a single common point. This is also an isolated connection (from ground).

The Modbus Map for the Analog Output Module (and operating details) can be found in the *Modbus Communicating I/O Modules* Manual.

9.5.2: Normal Mode

Normal Mode is the same for the 0-1mA and the 4-20mA Analog Output Modules except for the number of processes performed by the modules.

Both devices:

1. Accept new values through communication.

2. Output current loops scaled from previously accepted values.

The 0-1mA module includes one more process in its Normal Mode:

3. Read and average the A/D and adjust values for Process 2 above.

The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 msec

Normal Operation is prevented by a number of occurrences. See Section 9.4 for details.

9.6: Analog Input Modules

Analog Input Module Specifications	
Model Numbers	8AI1: 8-channel analog input 0±1mA
	8AI2: 8-channel analog input 0±20mA
	8AI3: 8-channel analog input 0±5VDC
	8AI4: 8-channel analog input 0±10VDC
Accuracy	0.25% of Full Scale
Scaling	Programmable
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	15-20VDC @50-200mA; 1250/1252 supports up to four modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Maximum Load Impedance	0±1mA: 10k Ohms; 4-20mA: 500 Ohms
Factory Settings	Modbus Address: 8AI1: 136; 8AI2: 140; 8AI3: 144; 8AI4: 148
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20msec

9.6.1: Overview

The Analog Input Modules (0±1mA, 0±20mA, 0±5Vdc and 0±10Vdc) are available in 8-channel format. Maximum registers per request, read or write, is 17 registers.

The Nexus® 1250/1252 meter supplies power for up to 4 connected Analog Input modules. See Section 9.2 for power and communication details. Refer to Section 5.6.2 to determine if you must use an additional power source, such as EIG's PSIO.

All inputs share a single common point. This is also an isolated connection (from ground).

The Modbus Map for the Analog Output Module (and operating details) can be found in the *Modbus Communicating I/O Modules* Manual.

9.6.2: Normal Mode

In Normal Mode, the Input Module:

1. Reads and averages the A/D and adjusts values for process 2.

2. Calculates the percentage of Input Value.

NOTE: The percentage value of the Input is stored in Input Value Registers (Registers 04097-04104).

The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 msec

Normal Operation is prevented by a number of occurrences. See Section 9.4 for details.

9.7: Digital Dry Contact Relay Output (Form C) Module

Digital Dry Contact Relay Output Module Specifications	
Model Number	4RO1: 4 matching relay outputs
Contact Type	Changeover (SPDT)
Relay Type	Mechanically latching
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	2.0W max @ 12-20VDC
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Switching Voltage	AC 250V / DC 30V
Switching Power	1250VA / 150W
Switching Current	5A
Mechanical Life	5 x 10^{7} switching operations
Electrical Life	10^{5} switching operations at rated current
Factory Settings	Modbus Address: 156
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20msec

9.7.1: Overview

The Relay Output Module consists of four Latching Relay Outputs. In Normal Mode, the device accepts commands to control the relays. Relay output modules are triggered by limits programmed with the Communicator EXT software. See the *Communicator EXT User Manual* for details on programming limits.

The Nexus® 1250/1252 meter supplies power for up to 4 connected Relay Output modules. See Section 9.2 for power and communication details. Refer to Section 5.6.2 to determine if you must use an additional power source, such as EIG's PSIO.

The Modbus Map for the Analog Output Module (and operating details) can be found in the *Modbus Communicating I/O Modules* Manual.

Each latching relay will hold its state in the event of a power loss.

9.7.2: Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 msec

Some situations will cause the device to operate with the above Default Parameters. See Section 9.4 for details of Default Mode.

9.7.3: Normal Mode

Normal Mode consists of one process: the device accepts new commands to control the relays.

9.8: Digital Solid State Pulse Output (KYZ) Module

Digital Solid State Pulse Output Module Specifications	
Model Number	4PO1
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	15-20VDC @50-200mA; 1250/1252 supports up to four modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Voltage Rating	Up to 300VDC
Commands Accepted	Read and Write with at least 4 registers of data per command
Memory	256 Byte IC EEPROM for storage of programmable settings and non-volatile memory
Factory Settings	Modbus Address: 160
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20msec

9.8.1: Overview

The KYZ Pulse Output Modules have 4 KYZ Pulse Outputs and accept Read and Write Commands with at least 4 registers of data per command. Digital Solid State Pulse Output (KYZ) Modules are user programmed to reflect VAR-hours, Watt-hours, or VA-hours. See the *Modbus Communicating I/O Modules User Manual* for details on programming the module.

The Nexus® 1250/1252 meter supplies power for up to 4 connected KYZ Pulse Output modules. See Section 9.2 for power and communication details. Refer to Section 5.6.2 to determine if you must use an additional power source, such as EIG's PSIO.

The Modbus Map for the KYZ Pulse Output Module (and operating details) can be found in the *Modbus Communicating I/O Modules Manual*.

NC = Normally Closed; NO = Normally Open; C = Common.

9.8.2: Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following Default Mode Parameters. See Section 9.4 for details.

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 msec

9.8.3: Normal Mode

Energy readings are given to the device frequently. The device generates a pulse at each channel after a certain energy increase.

Normal Operation consists of three processes:

1. The first process accepts writes to registers 04097 - 04112. Writes can be up to four registers long and should end on the fourth register of a group (register 04100, or registers 04103-04112 or registers 04109-04112). These writes can be interpreted as two-byte, four-byte, six-byte or eight-byte energy readings. The reception of the first value for a given channel provides the initial value for that channel. Subsequent writes will increment the Residual for that channel by the difference of the old value and the new value. The previous value is then replaced with the new value. Attempting to write a value greater than the programmed Rollover Value for a given channel is completely ignored and no registers are modified. If the difference is greater than half of the programmed Rollover Value for a given channel, the write does not increment the Residual but does update the Last Value. Overflow of the Residual is not prevented.

2. The second process occurs in the main loop and attempts to decrement the Residual by the Programmed Energy/Pulse Value. If the Residual is greater than the Programmed Energy/Pulse Value and the Pending Pulses Value for that channel has not reached the maximum limit, then Residual is decremented appropriately and the Pending Pulses is incremented by two, signifying two more transitions and one more pulse.

3. The third process runs from a timer which counts off pulse widths from the Programmable Minimum Pulse Width Values. If there are Pulses Pending for a channel and the delay has passed, then the Pulses Pending is decremented for that channel and the Output Relay is toggled.

Operation Indicator (0000H = OK, 1000H = Problem):

Bit 1:1 = EEPROM Failure

Bit 2:1 = Checksum for Communications Settings bad

Bit 3:1 = Checksum for Programmable Settings bad

Bit 4:1 = 1 or more Communications Settings are invalid

Bit 5:1 = 1 or more Programmable Settings are invalid

Bit 6:1 = 1 or more Programmable Settings have been modified

Bit 7:1 = Forced Default by Reset Value

Bit 15:1 = Normal Operation of the device is disabled

9.9: Digital Status Input Module

Digital Status Input Module Specifications	
Model Number	8DI1
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	15-20VDC @50-200mA; 1250/1252 supports up to four modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Voltage Rating	Up to 300VDC
Detection	Wet/Dry, Auto-detect
Memory	256 Byte I^2C EEPROM for storage of programmable settings and non-volatile memory
Factory Settings	Modbus Address: 164
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20msec

9.9.1: Overview

The Digital Status Input Module is used either for additional status detect or for accumulating pulses from external equipment, such as power meters, water meters, etc.

The Nexus® 1250/1252 meter supplies power for up to 4 connected Digital Status Input modules. See Section 9.2 for power and communication details. Refer to Section 5.6.2 to determine if you must use an additional power source, such as EIG's PSIO.

9.9.2: Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following Default Mode Parameters. See Section 9.4 for details.

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 msec

9.9.3: Normal Mode

The device polls the inputs at 100Hz (once every 10 msec), debouncing the inputs and incrementing the Transition Accumulators for each channel as appropriate.

The inputs are represented by Channel 1 in the LSB through Channel 8 in the MSB of the low order byte of the register.

The Modbus Map for the Digital Status Input Modules (and operating details) can be found in the *Modbus Communicating I/O Modules Manual*.

10: Meter with Internal Modem Option (INP2)

10.1: Hardware Overview

The Nexus® 1250/1252 meter with the INP2, Internal Modem Option, has all the components of the standard Nexus® meter plus the capability of connecting to a PC via a standard phone line. No additional hardware is required to establish this connection.

If desired, the internal expansion port of the Nexus® 1250/1252 meter can be configured with an internal 56K bps modem. This gives the meter Dial-In and Dial-Out capability without additional hardware. This configuration of the meter is ideal for small remote applications.

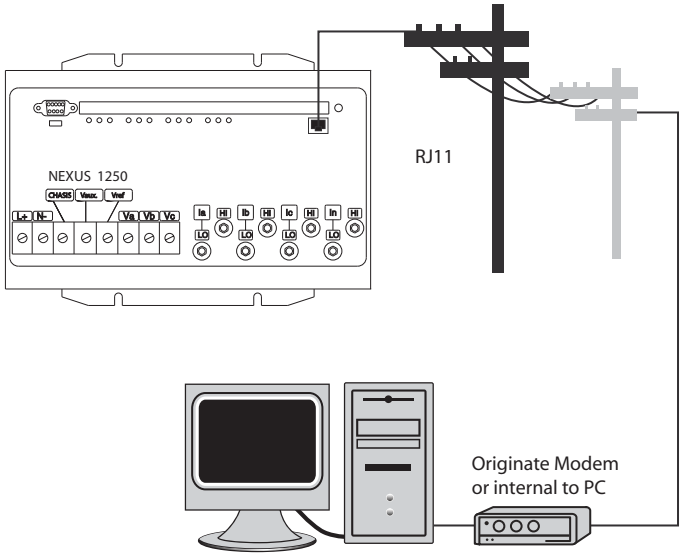


Figure 10.1: Meter Communication with Internal Modem Option

10.2: Hardware Connection

Use RJ11 Standard Telephone Line to connect with the Nexus® 1250/1252 meter. Insert the RJ11 line into the RJ11 Port on the face of a Nexus® meter with the Internal Modem Option. The RJ11 connection is virtually unlimited, since it utilizes a PSTN (Public Switched Telephone Network).

10.3: Dial-In Function

The modem continuously monitors the telephone line to detect an incoming call. When an incoming call is detected, the modem waits a pre-programmed number of rings and then answers the call. The modem can be programmed to check passwords and lock-out a user after unsuccessful attempts to connect.

When an incoming call is successfully connected, the control of communication passes to the calling software program. The modem respond to computer demands to down-load data or perform other actions authorized by the meter's passwords.

10.4: Dial-Out Function

The Dial-Out Function enabled by the INP2 Option allows the meter to automatically report certain conditions without direct user oversight. The modem normally polls the meter to determine if any abnormal or reportable conditions exist, such as those in the following list. If such conditions are found, the modem checks meter conditions and events, which have been programmed through Communicator EXT, to determine if a call should be placed.

- Are any meter set-point limits exceeded?
- Has the status of the High-Speed Inputs changed?
- Has a waveform been recorded?
- Has a power quality event been recorded?
- Has a control output changed?
- Is either history log approaching a full condition?
- Is the event log approaching a full condition?
- Is any other log approaching a full condition?
- Has the Modem Password failed?
- Has communication with the Nexus® meter failed?

If any of the monitored events exist, the modem automatically initiates a call to a specified location to make a report or perform some other function. For log full condi-

tions, the meter automatically downloads the log(s) that are nearing the full state. The modem can be programmed to call two different numbers to make the required reports: Primary and Backup.

The modem can be programmed with an ASCII string for identification purposes. If this string is present, the modem plays the string to the host computer upon connection to identify the meter to the host software. Refer to the *Communicator EXT User Manual* for programming details.

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11: Meter with Internal Network Option (INP200)

11.1: Hardware Overview

The Nexus® 1250/1252 meter with the Internal Network Option (INP200) has all the components of the standard Nexus® meter, plus giving you the capability of connecting to multiple PC's via Modbus/TCP over the Ethernet and providing a DNP LAN/WAN connection. Additional hardware is not required to establish a connection from a network to a Nexus® meter with the Internal Network Option.

With the Internal Network Option, the Nexus® 1250/1252 provides an Ethernet Gateway, allowing access to other Modbus/RTU devices. Additional connections can include a daisy chain of standard Nexus® and Shark® meters. A daisy chain can include up to 31 meters. You can install repeaters if you need to connect more than 31 meters. (See Section 5.7 for repeater details.)

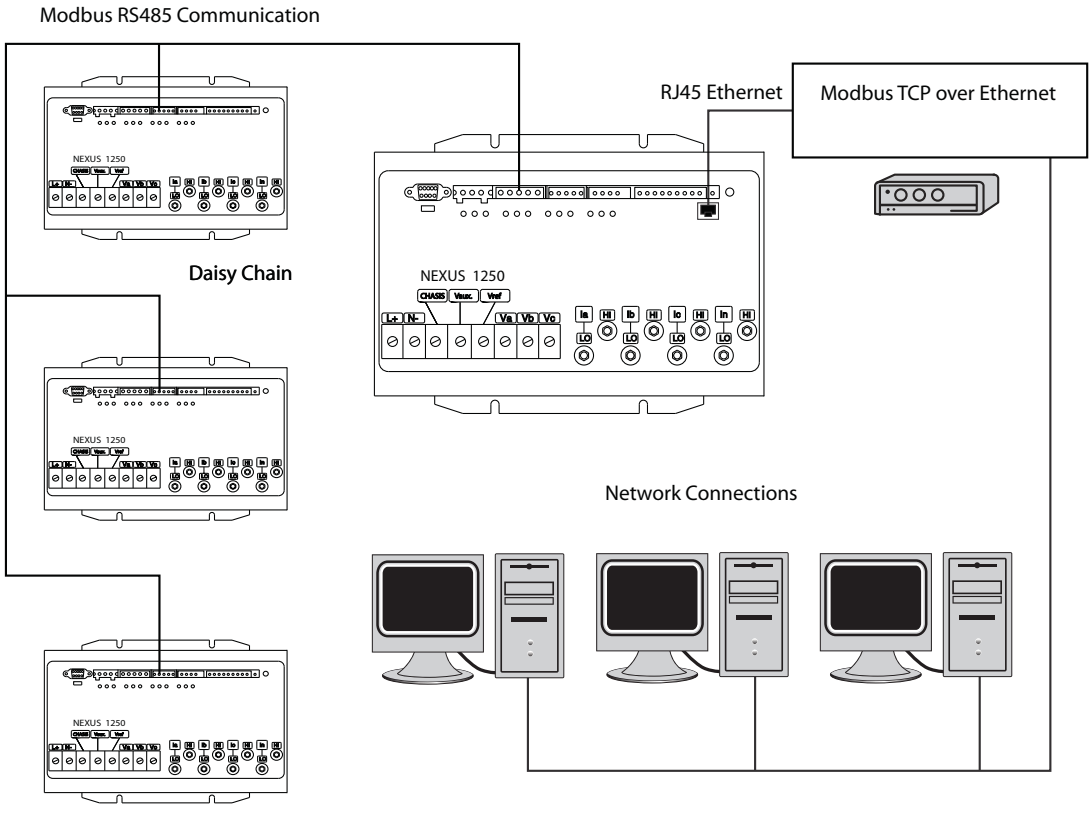

Figure 11.1: Meter Communication with Network Option/Daisy Chained Meters

The Internal Network Option of the Nexus® meter is an extremely versatile communications tool. The Internal Network Option:

- Adheres to IEEE 802.3 Ethernet standard using TCP/IP
- Utilizes simple and inexpensive 10/100BaseT wiring and connections
- Plugs into your network using built-in RJ45 jack
- Is programmable to any IP address, subnet mask and gateway requirements
- Communicates using the industry-standard Modbus/TCP and DNP LAN/WAN protocols.

With the Internal Network Option, the Nexus® 1250/1252 meter's Port 2 becomes a "gateway" that allows access to additional Nexus® meters via the LAN. Simply connect a daisy chain of Nexus® meters together via RS485, each with its own device address and using the same baud rates. With this option, you can access any of those instruments via the single LAN connection.

The Internal Network Option allows multiple simultaneous connections (via LAN) to the Nexus® meter. You can access the meter with SCADA, MV90 and RTU simultaneously.

The Internal Network Option allows multiple users running Communicator EXT software to access the meter concurrently.

11.2: Network Connection

Use Standard RJ45 10/100BaseT cable to connect with the Nexus® meter. Insert the RJ45 line into the RJ45 Port on the face of a Nexus® 1250/1252 meter with the Internal Network Option.

Set the IP Address using the following steps: (Refer to Section 3.3.5 of the *Communicator EXT User Manual* for more detailed instructions.)

1. From the Device Profile screen, double-click **General Settings> Communications**, then double-click on any of the ports. The Communications Settings screen opens.

2. In the Network Settings section enter the following data. (Consult your System Administrator if you do not know this information.)

   IP Address: 10.0.0.1 (Example)

   Subnet Mask: 255.255.255.0 (Example)

   Default Gateway: 0.0.0.0 (Example)

3. Click **OK** to return to the Device Profile screen.

Once the above parameters have been set, Communicator EXT connects via the network using a Device Address of "1" and the assigned IP Address when you follow these steps:

1. Open Communicator EXT.

2. Click the **Connect** icon in the icon tool bar. The Connect screen opens.

3. Click the Network button at the top of the screen. Enter the following information:

   Device Address: 1

   Host: IP Address

   Network Port: 502

   Protocol: Modbus TCP

4. Click the **Connect** button at the bottom of the screen. Communicator EXT connects to the meter via the network.

To connect with other Nexus® meters in either local or remote locations, you **must** use the Ethernet Gateway as a Master and an RS485 connection to any port on the remote Nexus.

The Address of the remote Nexus® meter **must** be something other than "1." "1" is reserved for the meter connected to the network via RJ45.

The link using RS485 is viable for up to 4000 feet (1219 meters).

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12: Flicker and Analysis

12.1: Overview

Flicker is the sensation that is experienced by the human visual system when it is subjected to changes occurring in the illumination intensity of light sources. The primary effects of Flicker are headaches, irritability and, sometimes, epileptic seizures.

IEC 61000-4-15 and former IEC 868 describe the methods used to determine Flicker severity. This phenomenon is strictly related to the sensitivity and the reaction of individuals. It can only be studied on a statistical basis by setting up suitable experiments among people.

The Nexus® 1250/1252 meter with V-1 (base configuration) offers Flicker monitoring and analysis. The Nexus® 1252 meter with V-2 has EN50160/IEC61000-4-30 Power Quality Compliance analysis for Flicker and other power quality measurements. (Refer to the V-Switch™ key information in Chapter 2.) Refer to Chapters 16 (EN50160/IEC61000-4-30 Power Quality Compliance Analysis) and 17 (EN50160/IEC61000-4-15 Flicker) of the *Communicator EXT User Manual* for additional information.

12.2: Theory of Operation

Flicker can be caused by voltage variations that are in turn caused by variable loads, such as arc furnaces, laser printers and microwave ovens. In order to model the eye brain change, which is a complex physiological process, the signal from the power network has to be processed while conforming with Figure 12.1, shown on page 12-4.

- Block 1 consists of scaling circuitry and an automatic gain control function that normalizes input voltages to Blocks 2, 3 and 4. For the specified 50 Hz operation, the voltage standard is 230 V RMS.

- Block 2 recovers the voltage fluctuation by squaring the input voltage scaled to the reference level. This simulates the behavior of a lamp.

- Block 3 is composed of a cascade of two filters and a measuring range selector. In this implementation, a log classifier covers the full scale in use so the gain selection is automatic and not shown here. The first filter eliminates the DC component and the double mains frequency components of the demodulated output. The configura-

tion consists of a .05 Hz Low High Pass filter and a 6 Pole Butterworth Low Pass filter located at 35 Hz. The second filter is a weighting filter that simulates the response of the human visual system to sinusoidal voltage fluctuations of a coiled filament, gas-filled lamp (60 W - 230 V). The filter implementation of this function is as specified in IEC 61000-4-15.

- Block 4 is composed of a squaring multiplier and a Low Pass filter. The Human Flicker Sensation via lamp, eye and brain is simulated by the combined non-linear response of Blocks 2, 3 and 4.

- Block 5 performs an online statistical cumulative probability analysis of the Flicker level. Block 5 allows direct calculation of the evaluation parameters Pst and Plt.

Flicker Evaluation occurs in the following forms: Instantaneous, Short Term or Long Term. Each form is detailed below:

- Instantaneous Flicker Evaluation: An output of 1.00 from Block 4 corresponds to the Reference Human Flicker Perceptibility Threshold for 50% of the population. This value is measured in Perceptibility Units (PU) and is labeled Pinst. This is a real time value and it is continuously updated.

- Short Term Flicker Evaluation: An output of 1.00 from Block 5 (corresponding to the Pst value) corresponds to the conventional threshold of irritability per IEC 1000-3-3. In order to evaluate Flicker severity, two parameters have been defined: one for the short term called Pst (defined in this section) and one for the long term called Plt (defined in the next section).

  The standard measurement time for Pst is 10 minutes. Pst is derived from the time at level statistics obtained from the level classifier in Block 5 of the Flicker meter. The following formula is used:

$$P_{st} = \sqrt{0.0314P_{0.1} + 0.0525P_{1s} + 0.0657P_{3s} + 0.28P_{10s} + 0.08P_{50s}}$$

  ,where the percentiles P(0.1), P(1), P(3), P(10), P(50) are the Flicker levels exceeded for 0.1, 1, 2, 20 and 50% of the time during the observation period. The suffix S in the formula indicates that the smoothed value should be used. The smoothed values are obtained using the following formulas:

  P(1s) = (P(.7) + P(1) + P(1.5))/3

P(3s) = (P(2.2) + P(3) + P(4))/3

P(10s) = (P(6) + P(8) + P(10) + P(13) + P(17))/5

P(50s) = (P(30) + P(50) + P(80))/3

The .3-second memory time constant in the Flicker meter ensures that P(0.1) cannot change abruptly and no smoothing is needed for this percentile.

- Long Term Flicker Evaluation: The 10-minute period on which the short-term Flicker severity is based is suitable for short duty cycle disturbances. For Flicker sources with long and variable duty cycles (e.g. arc furnaces) it is necessary to provide criteria for long-term assessment. For this purpose, the long-term Plt is derived from the short-term values over an appropriate period. By definition, this is 12 short-term values of 10 minutes each over a period of 2 hours. The following formula is used:

$$P_{lt} = \sqrt[3]{\frac{\sum_{i=1}^{N} P_{sti}^3}{N}}$$

where Psti (i = 1, 2, 3, ...) are consecutive readings of the short-term severity Pst.

12.2.1: Summary

Flicker is changes in the illumination of light sources due to cyclical voltage variations.

Pinst is Instantaneous Flicker values in Perceptibility Units (PU).

Pst is value based on 10-minute analysis.

Plt is value based on 12 Pst values.

Measurement Procedure

1. Original Signal with amplitude variations

2. Square demodulator

3. Weighted filter

4. Low pass filter 1st order

5. Statistical computing

Data available

- Pst, Pst Max, Pst Min values for short term recording
- Plt, Plt Max, Plt Min values for long term recording

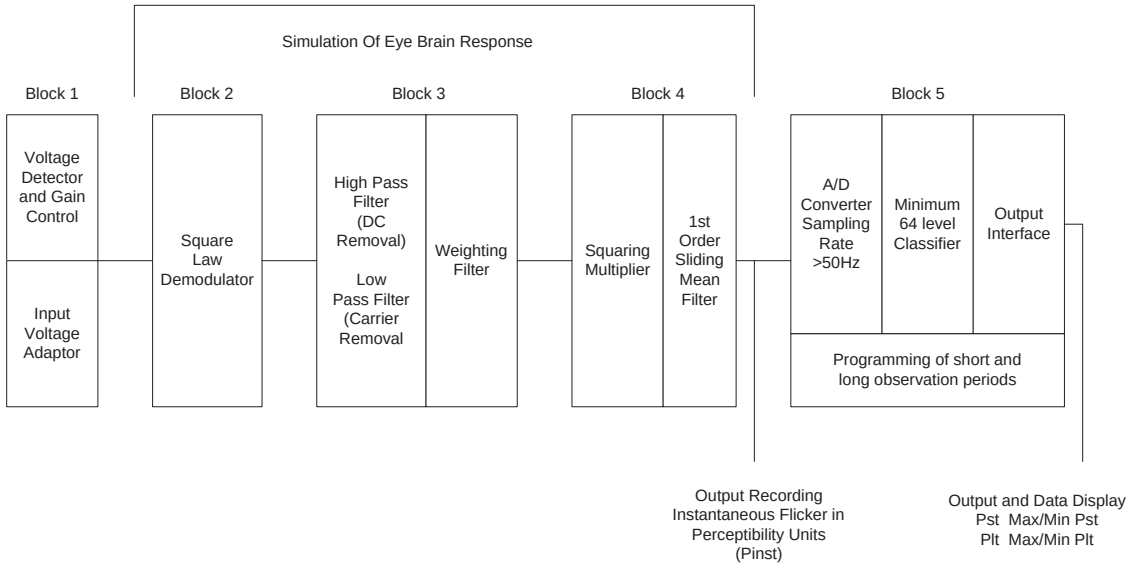


Figure 12.1: Simulation of Eye Brain Response

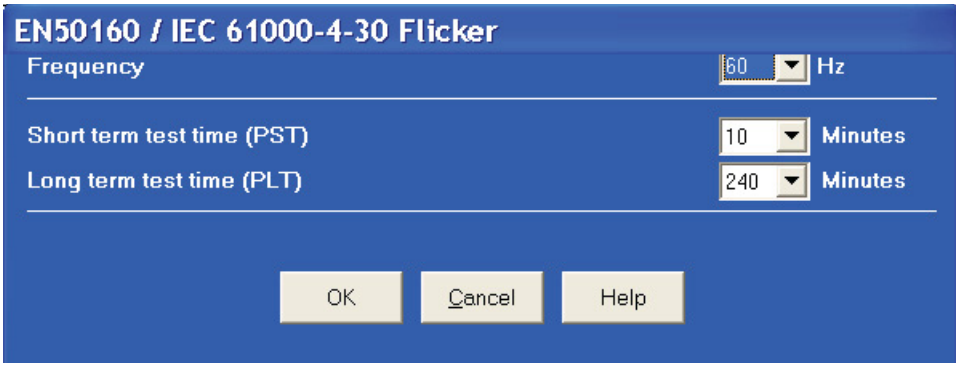
12.3: Flicker Setting (Nexus® 1250 meter and 1252 V-1)

You must set up several parameters to properly configure Flicker.

NOTE: If your Nexus® 1252 meter has V-Switch key 2, see Section 12.9 for instructions on configuring EN50160/IEC61000-4-30 Power Quality Compliance analysis, including Flicker.

1. Select the **Profile** icon from Communicator EXT's Icon bar.

2. From the Device Profile screen, double-click **Power Quality and Alarm Settings>EN50160/IEC61000-4-30 Flicker**. You will see the screen shown below.



- Select the Frequency of operation. 50 Hz is the approved frequency according to Flicker standards. A 60 Hz implementation is available and can be selected.

  Remember the voltage is normalized. For 50 Hz, the normalized voltage is 230 V and for 60 Hz, the normalized voltage is 120 V.

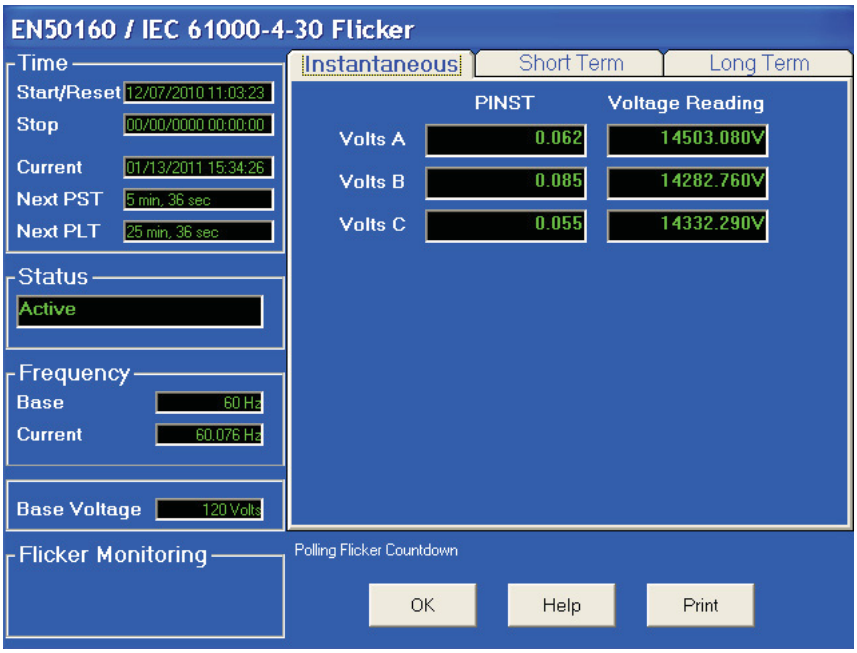
- Select a Short Term Test Time (PST) time range from 1 to 10 minutes. The standard measurement period is nominally 10 minutes.

- Select a Long Term Test Time (PLT) time range from 1 to 240 minutes. The standard measurement is nominally 12 Pst periods (120 minutes). Plt time must always be equal to or greater than and a multiple of Pst time. This is reflected in the available selections.

3. Click **OK** when you are finished.

12.4: Flicker Polling Screen

1. From the Communicator EXT Title bar, select **Real-Time Poll>Power Quality and Alarms>Flicker**. You will see the screen shown below.



Main screen:

This section describes the Main Screen functions. These functions are found on the left side of the screen.

Time

- Start/Reset is the time when Flicker was started or reset. A Reset of Flicker causes the Max/Min values to be cleared and restarts the Flicker Pst and Plt timers. A Start of Flicker is also equivalent to a Reset in that the PST and PLT are restarted and the Max/Min Values are cleared.
- Stop corresponds to the time when Flicker is turned off.
- Current is the current clock time.
- Next Pst is the countdown time to when the next Pst value is available.
- Next Plt is the countdown time to when the next Plt value is available.

Status

- This screen indicates the current status: Active = On; Stopped = Off.

Frequency

- Base is the operating frequency (50 or 60 Hz) selected in the EN50160 Flicker screen (see Section 12.3).
- Current is the real-time frequency measurement of the applied voltage.

Base Voltage

- This field shows the normalized voltage for the selected frequency (230 V for 50 Hz or 120 V for 60 Hz).

Flicker Monitoring

- Clicking on **Stop** causes Flicker to stop being processed and freezes all the current values. Stop Time is recorded and the current Max/Min values are cleared.
- Clicking on **Start** starts Flicker processing. Start Time is recorded.
- Clicking on **Reset** causes the Max/Min values to be cleared and restarts the Flicker Pst and Plt timers.

Use the tabs at the top of the screen to navigate to the Instantaneous, Short Term, and Long Term Readings views, shown on the right side of the screen.

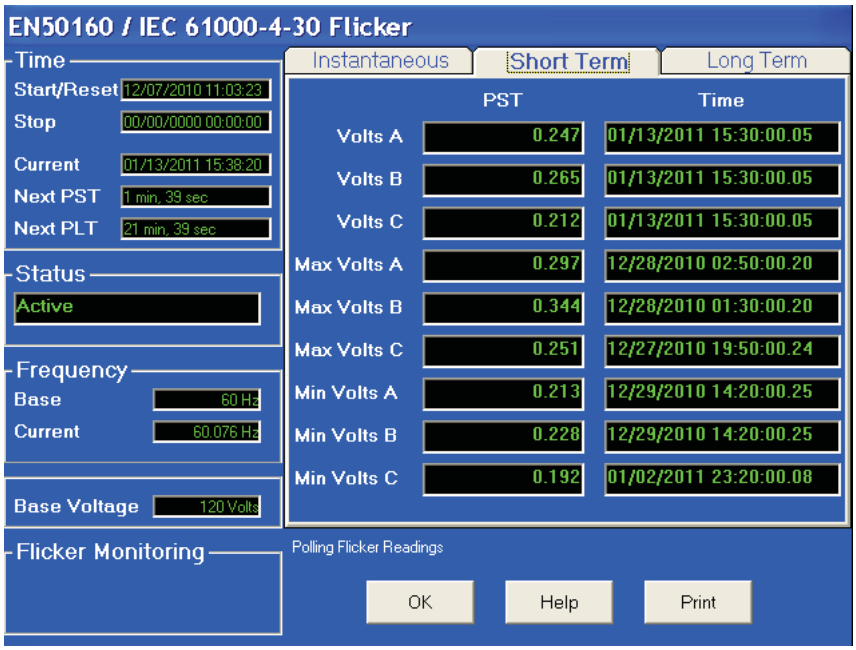
Instantaneous Readings

NOTE: The Instantaneous view is the default of this screen. (See the screen pictured on the previous page.) If you are in the Short or Long Term views, click on the Instantaneous tab to display this view.

- The PU values, Pinst for Voltage Inputs Va, Vb and Vc are displayed here and are continuously updated. The corresponding Current Voltage values for each channel are displayed for reference.

Short Term Readings

Click on the Short Term tab to access a screencontaining three groups of Pst readings (shown below).

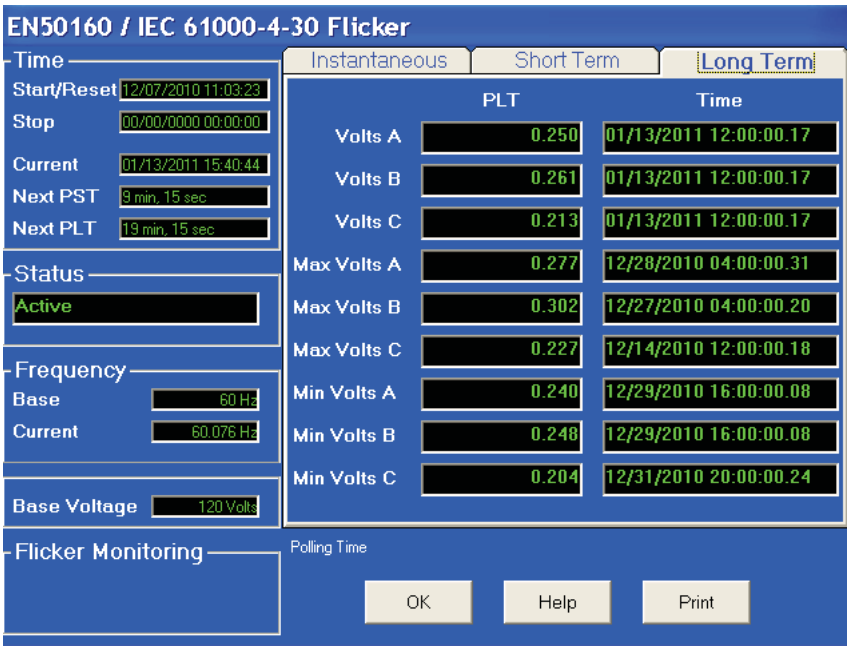


Pst readings displayed:

- Current Pst values for Va, Vb and Vc and the time of computation
- Current Pst Max values for Va, Vb and Vc since the last reset and the time of the last reset
- Current Pst Min values for Va, Vb and Vc since the last reset and the time of the last reset

Long Term Readings

1. Click on the Long Term tab to access a screen containing three groups of Plt readings (shown below).



Plt readings displayed:

- Current Plt values for Va, Vb and Vc and the time of computation
- Current Plt Max values for Va, Vb and Vc since the last reset and the time of the last reset
- Current Plt Min values for Va, Vb and Vc since the last reset and the time of the last reset

2. Click **OK** to exit the EN50160/IEC61000-4-30 Flicker Polling screen; click **Print** to print all of the Readings views.

12.5: Logging

The Nexus® 1250/1252 meter is capable of logging Flicker values in an independent log. When Flicker is on, entries are made into the log in accordance with the times that associated values occur. Pst, Pst Max, Pst Min, Plt, Plt Max, Plt Min, Start/Reset and Stop times are all recorded. All values can be downloaded to the Log Viewer where they are available for graphing or export to another program, such as Excel. All Flicker values are predefined and cannot be changed. Refer to Chapter 8 of the *Communicator EXT User Manual* for additional instructions concerning the Flicker log.

12.6: Polling through a Communication Port

The Pinst, Pst, Pst Max, Pst Min, Plt, Plt Max, Plt Min values can be polled through the Communications Port. Refer to the Nexus® 1250 and 1252 meters' Modbus and DNP Mapping manuals for register assignments and data definitions.

12.7: Log Viewer

1. Open Log Viewer by selecting the **Open Logs** icon from Communicator EXT's Icon bar.

2. Using the menus at the top of the screen, select a meter, time ranges and values to access.

3.Click the **Flicker** icon.

The values and the associated time stamps (when the values occurred) are displayed in a grid box. Use the buttons at the bottom of the screen to create a graph or export the data to another program.

- Graphed values include Pst and Plt Va, Vb and Vc.

- Displayed values include Pst and Plt Max and Min for Va, Vb and Vc.

NOTE: Max and Min values are only displayed; they cannot be graphed. However, Max and Min values are available for export.

12.8: Performance Notes

Pst and Plt average time are synchronized to the clock (e.g. for a 10 minute average, the times will occur at 0, 10, 20, etc.). The actual time of the first average can be less than the selected period to allow for initial clock synchronization.

If the wrong frequency is chosen (e.g. 50Hz selection for a system operating at 60Hz), Flicker will still operate but the computed values will not be valid. Therefore, you should select the frequency setting with care.

User settings are stored. If Flicker is on and power is removed from the meter, Flicker will still be on when power returns. This can cause gaps in the logged data.

The Max and Min values are stored, and are not lost if the unit is powered down.

Flicker meets the requirements of IEC 61000-4-15 and former IEC 868. Refer to those specifications for more details, if needed. Meters with the EN50160 option also meet the EN50160 conformance standards for Flicker. Refer to chapters 16 and 17 in the *Communicator EXT User Manual* for additional information.

Operation is at 230V for 50Hz and 120V for 60Hz as per specification. If the input voltage is different, the system will normalize it to 230V or 120V for computational purposes.

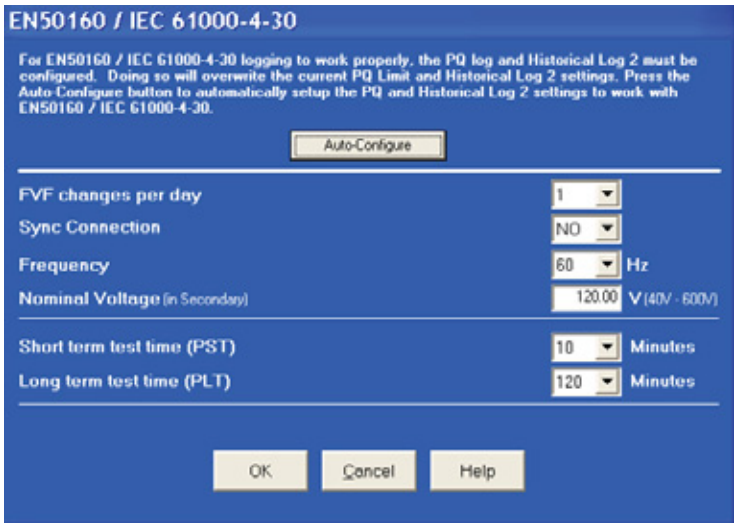
12.9: EN50160 / IEC61000-4-30 Power Quality Compliance Analysis (Nexus® 1252 meter with V-2)

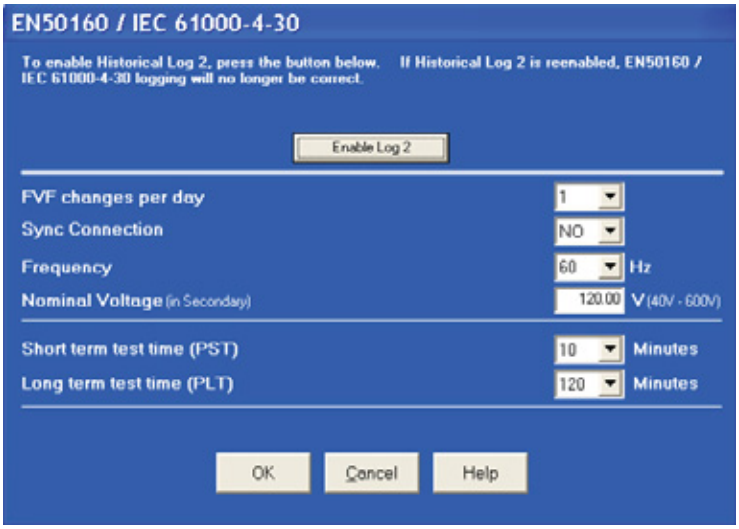
If your Nexus® 1252 meter is equipped with V-Switch™ key 2, you have access to the EN50160/IEC61000-4-30 PQ Compliance analysis function, as well as to Flicker measurement.

12.9.1: EN50160 / IEC61000-4-30 Configuration

1. Select the Profile icon from Communicator EXT's Icon bar.

2. From the Device Profile screen, double-click Power Quality and Alarm Settings>EN50160/IEC61000-4-30. Depending on your current setting, you will see one of the following screens.


EN50160 / IEC 61000-4-30
For EN50160 / IEC 61000-4-30 logging to work properly, the PQ log and Historical Log 2 must be configured. Doing so will overwrite the current PQ Limit and Historical Log 2 settings. Press the Auto-Configure button to automatically setup the PQ and Historical Log 2 settings to work with EN50160 / IEC 61000-4-30.
Auto-Configure
FVF changes per day
1
Sync Connection
NO
Frequency
60
Hz
Nominal Voltage (in Secondary)
120.00
V (40V - 600V)
Short term test time (PST)
10
Minutes
Long term test time (PLT)
120
Minutes
OK
Cancel
Help



3. The Nexus® 1252 meter with V-2 can use Historical Log 2 to record the results of Flicker testing: you will see the top screen if EN50160/IEC61000-4-30 logging has not been selected for the meter; you will see the bottom screen if it has already been selected.

   - To set up EN50160/IEC61000-4-30 recording, click **Auto-Configure**. Historical Log 2 will now be used for EN50160/IEC61000-4-30 logging, only.

   - If EN50160/IEC61000-4-30 recording is already active and you want to disable it, click **Enable Log 2**. This will disable the EN50160/IEC61000-4-30 logging in Historical Log 2. You can then configure Historical Log 2 normally. (See Chapter 3 of the *Communicator EXT User Manual* for instructions)

   NOTE: It takes a week for the meter to collect all the data needed for the analysis.

4. Make the following selections:

   a. FVF: select the number of Fast Voltage Fluctuations that are acceptable per day.

   b. Sync Connection: select YES for a system with a synchronous connection to another system, NO if there is no such synchronous connection.

   c. Select your Frequency (50 Hz or 60Hz).

   d. Nominal Voltage (in Secondary): Enter the value for the Nominal voltage in Secondary that you want to use in the analysis; for example, 120 V for a 60 Hz frequency, or 230 V for a 50 Hz frequency.

   e. Short Term Test Time: Select the time in minutes for the PST - short-term test. The available range is from 1-10 minutes.

   f. Long Term Test Time: Select the time in minutes for the LST - long-term test. The available range is 10-240 minutes, in multiples of 10 (10, 20, 30, etc.).

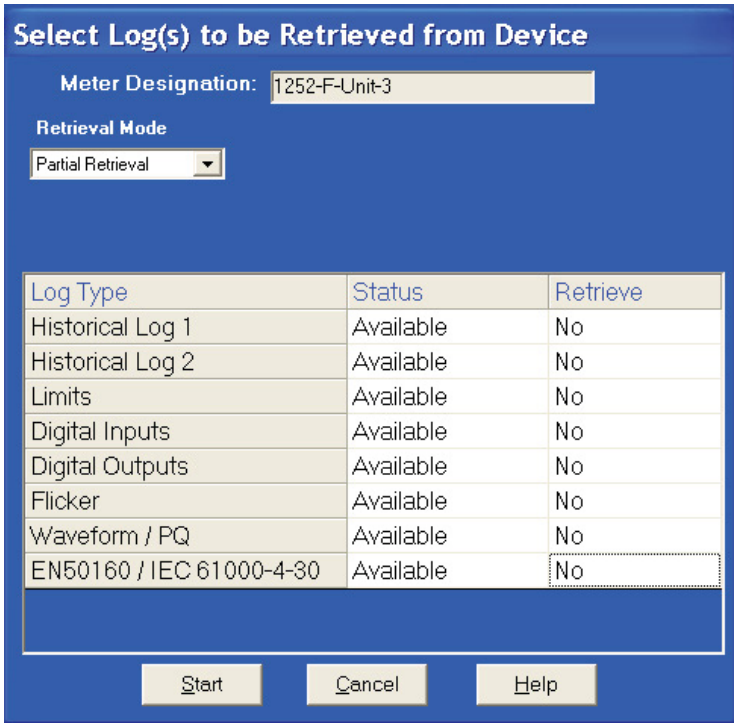
5. Click **OK**.

6. Click **Update Device** to send the new settings to the meter and return to the main Communicator EXT screen.

12.9.2: EN50160 / IEC61000-4-30 Analysis

NOTE: A full week of logging is necessary before an EN50160/IEC61000-4-30 analysis can be created.

1. From the Communicator EXT toolbar, click **Logs>Retrieve Logs from Device(s)** or click the **Retrieve Logs** icon. You will see the screen shown below.



2. Double-click the No to the right of EN50160/IEC61000-4-30.

3. You will see a pop-up window displaying the message: "Updated Related Logs (PQ and Historical Log 2)." Click **OK**.

4. The No changes to a Yes next to the Historical Log 2, Waveform/PQ, and EN50160/IEC61000-4-30 logs.

5. Click **Start** to begin retrieving the logs. Communicator EXT retrieves the selected logs and automatically creates a database for you. Pop-ups confirm the retrieval and conversion.

6. The Log Viewer screen appears. (See Chapter 8 of the *Communicator EXT User Manual* for additional information on using the Log Viewer.)

7. Click the EN50160/IEC61000-4-30 button. A screen shows the data points required. Click **YES**.

8. A list of all weeks collected for this meter is displayed. Information provided includes:

   - Start/End Time of Week
   - Device Name
   - Nominal Frequency / Voltage
   - Pass / Fail Value for each component

9. Select a week from those displayed.

10. Click the IEC 61000-4-30 button at the bottom of the screen. A full analysis is generated.

11. The EN50160/IEC61000-4-30 HTML Viewer screen is displayed. See Chapter 16 in the *Communicator EXT User Manual* for detailed instructions on using the EN50160/ IEC61000-4-30 HTML Viewer screen.

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13: Substation 19-inch Rack Mount Assembly (Nexus® 1252 Meter)

13.1: Overview

The Nexus® 1252 meter can be ordered in a 19-inch rack mount assembly for use in modern substation control apparatus. The assembly houses the Nexus® 1252 meter, a Test switch, and three LED displays. The assembly is pre-wired and pre-labeled for easy installation. An example assembly is shown below. Figure 13.3 shows the assembly components from the back.

13.1: Front of Rack Mount Assembly

13.2: Features

- Ideal for substation 19-inch rack mount control panel applications
- Incorporates three displays: Amps, Power, and Volts
- Has a front panel download port
- Equipped with a built-in Test switch (accessed from the rear of the assembly)

13.3: Options

The rack assembly is equipped with three LED displays:

- P40N+: Master LED display providing either multifunction measurement or use as a Volts master unit. The P40N+ is the standard display for the rack assembly.
- P41N+: An LED Amps display which is a slave display.
- P43N+: An LED Power display which is a slave display.

13.4: Dimensions

The dimensions for the Nexus® 1252 rack assembly are:

- Length: 19 inches/482.6mm
- Height: 7 inches/177.8 mm (4 Rack units)
- Depth: 14 inches/355.6 mm

13.5: Installation

The rack assembly is 4 Rack units high. It has four screw holes for attaching to the panel.

1. Align the rack assembly's screw holes with the holes in the panel (see Figure 13.2.)
2. Insert two screws on each side of the rack assembly into the panel to secure it.

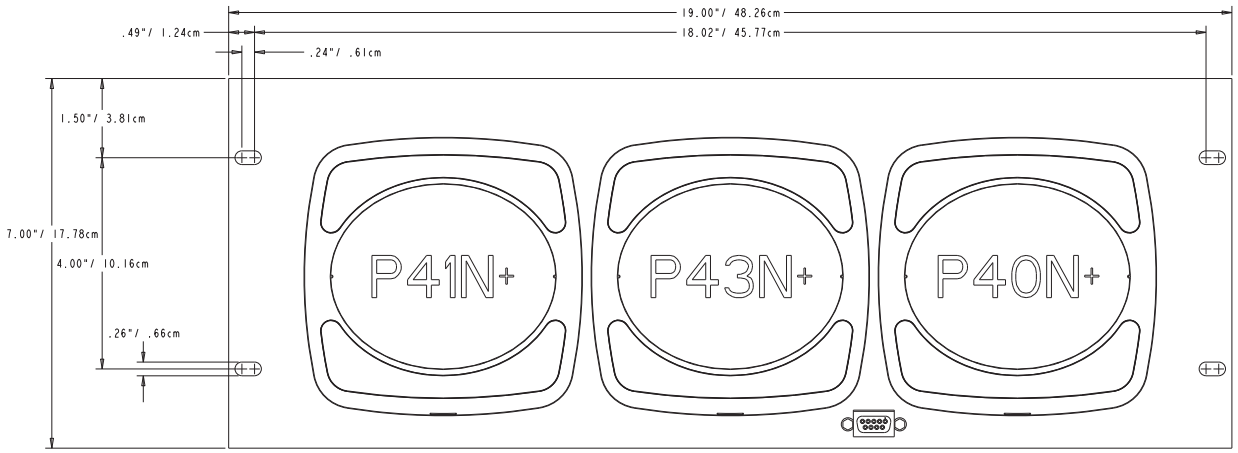

Figure 13.2: Rack Assembly Dimensions

13.6: Wiring

The voltage and current signals from the potential and current transformers should be connected to the Test switch (see Figure 13.4). There are positions for voltage and current phases A, B, and C, Neutral voltage, and DC Power supply. The Test switches are labeled for easy wiring.

Please follow the Nexus® 1252 meter wiring diagrams concerning proper connections (see Section 4.9).

13.7: Ordering Information

The rack assembly ordering code is 4RU3DSP. It is placed at the end of the Nexus® 1252 meter order, for example:

1252-A-120-D-60-V1-X-X-4RU3DSP

which translates to a Nexus® 1252 meter with Advanced memory, 120 Input Voltage option, D Power Supply option, 60Hz, V-Switch™ key 1, no expansion port, no Revenue Seal, and in the rack assembly.

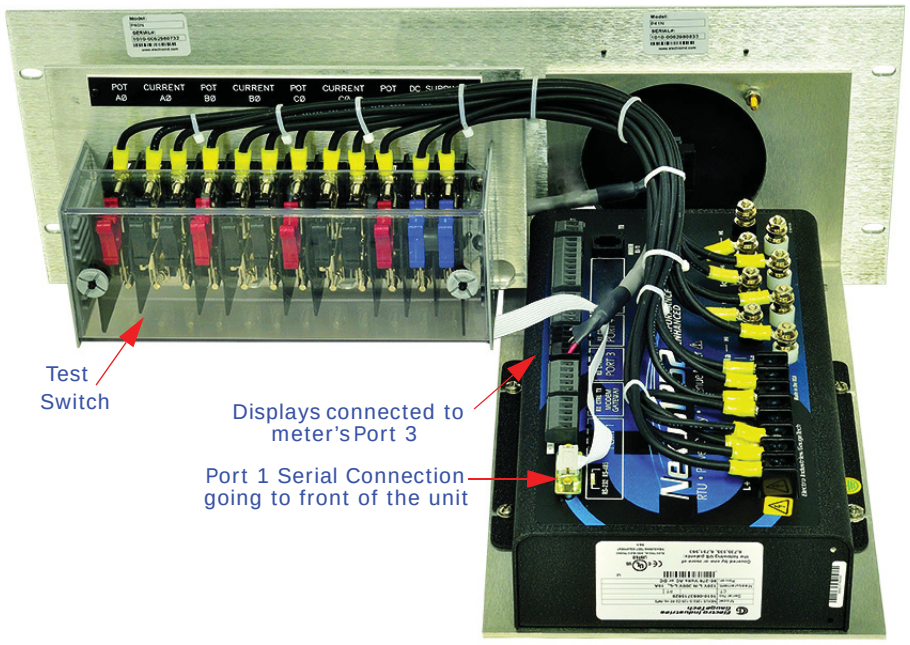

Figure 13.3: Back of Rack Assembly

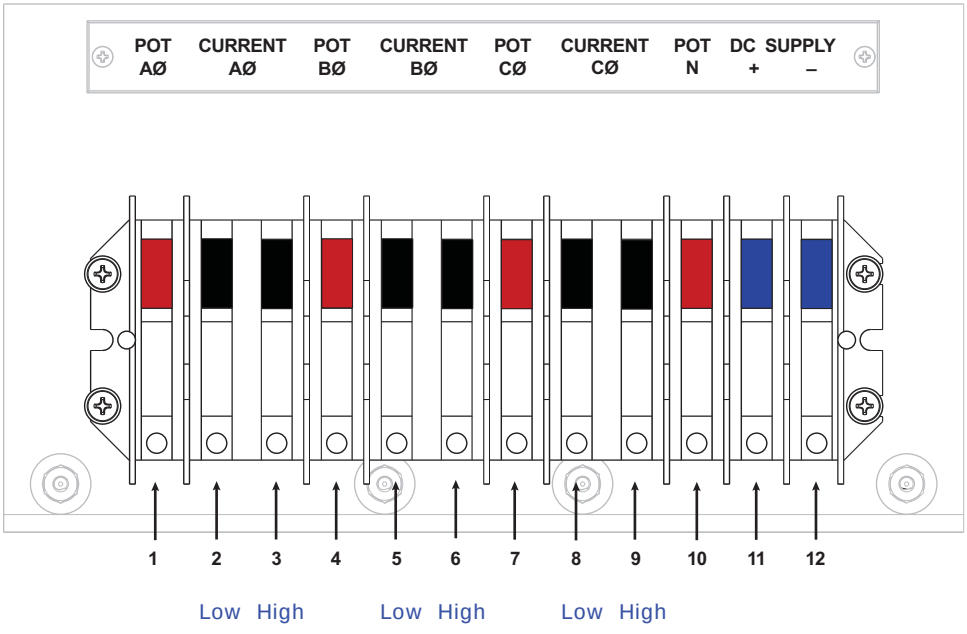

Figure 13.4: Detail of Test Switches

Glossary

0.2 Second Values:	These values are the RMS values of the indicated quantity as calculated after approximately 200 milliseconds (3 cycles) of sampling.
1 Second Values:	These values are the RMS values of the indicated quantity as calculated after one second (60 cycles) of sampling.
Alarm:	An event or condition in a meter that can cause a trigger or call-back to occur.
Annunciator:	A short label that identifies particular quantities or values displayed, for example kWh.
Average (Current):	When applied to current values (Amps) the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, Average Amps is the thermal average of Amps over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100Amp load is applied, the thermal average will indicate 90 amps after one time interval, 99 amps after two time intervals and 99.9 amps after three time intervals.
Average (Input Pulse Accumulations:	When applied to Input Pulse Accumulations, the "Average" refers to the block (fixed) window average value of the input pulses.

Average (Power):	When applied to power values (Watts, VARs, VA), the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, the Average Watts is the thermal average of Watts over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100kW load is applied, the thermal average will indicate 90kW after one time interval, 99kW after two time intervals and 99.9kW after three time intervals.
Bit:	A unit of computer information equivalent to the result of a choice between two alternatives (Yes/No, On/Off, for example). Or, the physical representation of a bit by an electrical pulse whose presence or absence indicates data.
Binary:	Relating to a system of numbers having 2 as its base (digits 0 and 1).
Block Window Avg (Power):	The Block (Fixed) Window Average is the average power calculated over a user-set time interval, typically 15 minutes. This calculated average corresponds to the demand calculations performed by most electric utilities in monitoring user power demand. (See Rolling Window Average.)

Byte:	A group of 8 binary digits processed as a unit by a computer (or device) and used especially to represent an alphanumeric character.
CBEMA Curve:	A voltage quality curve established originally by the Computer Business Equipment Manufacturers Association. The CBEMA Curve defines voltage disturbances that could cause malfunction or damage in microprocessor devices. The curve is characterized by voltage magnitude and the duration which the voltage is outside of tolerance. (See ITIC Curve.)
Channel:	The storage of a single value in each interval in a load profile.
Cold Load Pickup:	This value is the delay from the time control power is restored to the time when the user wants to resume demand accumulation.
CRC Field:	Cyclic Redundancy Check Field (Modbus communication) is an error checksum calculation that enables a Slave device to determine if a request packet from a Master device has been corrupted during transmission. If the calculated value does not match the value in the request packet, the Slave ignores the request.
CT (Current) Ratio:	A Current Transformer Ratio is used to scale the value of the current from a secondary value up to the primary side of an instrument transformer.
Cumulative Demand:	The sum of the previous billing period maximum demand readings at the time of billing period reset. The maximum demand for the most recent billing period is added to the previously

	accumulated total of the maximum demands.
Demand:	The average value of power or a similar quantity over a specified period of time.
Demand Interval:	A specified time over which demand is calculated.
Display:	User-configurable visual indication of data in a meter.
DNP 3.0:	A robust, non-proprietary protocol based on existing open standards. DNP 3.0 is used to operate between various systems in electric and other utility industries and SCADA networks.
EEPROM:	Nonvolatile memory; Electrically Erasable Programmable Read Only Memory that retains its data during a power outage without need for a battery. Also refers to meter's FLASH memory.
Energy Register:	Programmable record that monitors any energy quantity. Example: Watthours, VARhours, VAhours.
Ethernet:	A type of LAN network connection that connects two or more devices on a common communications backbone. An Ethernet LAN consists of at least one hub device (the network backbone) with multiple devices connected to it in a star configuration. The most common versions of Ethernet in use are 10BaseT and 100BaseT as defined in IEEE 802.3 standards. However, several other versions of Ethernet are also available.
Flicker:	Flicker is the sensation that is experienced by the human visual system when it is subjected to

	changes occurring in the illumination intensity of light sources. IEC 61000-4-15 and former IEC 868 describe the methods used to determine Flicker severity.
Harmonics:	Measuring values of the fundamental current and voltage and percent of the fundamental.
Heartbeat Pulse:	Energy indicator on the face of the Nexus® 1250/ 1252 meter; pulses are generated per the programmed Ke value.
I2T Threshold:	Data will not accumulate until current reaches programmed level.
Integer:	Any of the natural numbers, the negatives of those numbers, or zero.
Internal Modem:	An optional modem within the meter's enclosure that connects to the RJ11 telephone connector.
Invalid Register:	In the Nexus® meter's Modbus Map there are gaps between Registers. For example, the next Register after 08320 is 34817. Any unmapped Register stores no information and is said to be invalid.
ITIC Curve:	An updated version of the CBEMA Curve that reflects further study into the performance of microprocessor devices. The curve consists of a series of steps but still defines combinations of voltage magnitude and duration that will cause malfunction or damage.
Ke:	kWh per pulse; i.e. the energy.

kWh:	Kilowatt hours; kW x demand interval in hours.
KYZ Output:	Output where the rate of changes between 1 and 0 reflects the magnitude of a metered quantity.
LCD:	Liquid Crystal Display.
LED:	Light Emitting Diode.
Maximum Demand:	The largest demand calculated during any interval over a billing period.
Modbus ASCII:	Alternate version of the Modbus protocol that utilizes a different data transfer format. This version is not dependent upon strict timing, as is the RTU version. This is the best choice for telecommunications applications (via modems).
Modbus RTU:	The most common form of Modbus protocol. Modbus RTU is an open protocol spoken by many field devices to enable devices from multiple vendors to communicate in a common language. Data is transmitted in a timed binary format, providing increased throughput and therefore, increased performance.
Network:	A communications connection between two or more devices to enable those devices to send to and receive data from one another. In most applications, the network is either a serial type or a LAN type.
NVRAM:	Nonvolatile Random Access Memory: able to keep the stored values in memory even during the loss of circuit or control power. High speed NVRAM is used in the Nexus® meter to gather

	measured information and to insure that no information is lost.
Optical Port:	A port that facilitates infrared communication with a meter. Using an ANSI C12.13 Type II magnetic optical communications coupler and an RS232 cable from the coupler to a PC, the meter can be programmed with Communicator EXT software.
Packet:	A short fixed-length section of data that is transmitted as a unit. Example: a serial string of 8-bit bytes.
Percent (%) THD:	Percent Total Harmonic Distortion. (See THD.)
Protocol:	A language that is spoken between two or more devices connected on a network.
PT Ratio:	Potential Transformer Ratio used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as VT Ratio.
Pulse:	The closing and opening of the circuit of a two-wire pulse system or the alternate closing and opening of one side and then the other of a three-wire system (which is equal to two pulses).
Q Readings:	Q is the quantity obtained by lagging the applied voltage to a wattmeter by 60 degrees. Values are displayed on the Uncompensated Power and Q Readings screen.

Quadrant (Programmable Values and Factors on the Nexus® meter:)	Watt and VAR flow is typically represented using an X-Y coordinate system. The four corners of the X-Y plane are referred to as quadrants. Most power applications label the right hand corner as the first quadrant and number the remaining quadrants in a counter-clockwise rotation. Following are the positions of the quadrants: 1st - upper right, 2nd - upper left, 3rd - lower left and 4th - lower right. Power flow is generally positive in quadrants 1 and 4. VAR flow is positive in quadrants 1 and 2. The most common load conditions are: Quadrant 1 - power flow positive, VAR flow positive, inductive load, lagging or positive power factor; Quadrant 2 - power flow negative, VAR flow positive, capacitive load, leading or negative power factor.
Register:	An entry or record that stores a small amount of data.
Register Rollover:	A point at which a Register reaches its maximum value and rolls over to zero.
Reset:	Logs are cleared or new (or default) values are sent to counters or timers.
Rolling Window Average (Power):	The Rolling (Sliding) Window Average is the average power calculated over a user-set time interval that is derived from a specified number of sub-intervals, each of a specified time. For

example, the average is calculated over a 15-minute interval by calculating the sum of the average of three consecutive 5-minute intervals. This demand calculation methodology has been adopted by several utilities to prevent customer manipulation of kW demand by simply spreading peak demand across two intervals.

RS232: A type of serial network connection that connects two devices to enable communication between the devices. An RS232 connection connects only two points. Distance between devices is typically limited to fairly short runs.
Current standards recommend a maximum of 50 feet but some users have had success with runs up to 100 feet.
Communications speed is typically in the range of 1200 bits per second to 57,600 bits per second.
RS232 connection can be accomplished using Port 1 of the Nexus® 1250/1252 meter.

RS485: A type of serial network connection that connects two or more devices to enable communication between the devices. An RS485 connection allows multi-drop communication from one to many points.
Distance between devices is typically limited to around 2,000 to 3,000 wire feet.
Communications speed is typically in the range of 120 bits per second to 115,000 bits per second.

Sag: A voltage quality event during which the RMS voltage is lower than normal for a period of time, typically from 1/2 cycle to 1 minute.

Secondary Rated: Any Register or pulse output that does not use any CT or PT(VT) Ratio.

Serial Port: The type of port used to directly interface with a device using the RS232 standard.

Swell: A voltage quality event during which the RMS voltage is higher than normal for a period of time, typically from 1/2 cycle to 1 minute.

TDD: The Total Demand Distortion of the current waveform. The ratio of the root-sum-square value of the harmonic current to the maximum demand load current. (See equation below.)
NOTE: The TDD displayed in the Harmonics screen is calculated by Communicator EXT software, using the Max Average Demand.

$$1TDD = \sqrt{\frac{I_2^2 + I_3^2 + I_4^2 + I_5^2 + ...x100\%}{I_L}}$$

THD: Total Harmonic Distortion is the combined effect of all harmonics measured in a voltage or current. The THD number is expressed as a percent of the fundamental. For example, a 3% THD indicates that the magnitude of all harmonic distortion measured equals 3% of the magnitude of the fundamental 60Hz quantity. The %THD displayed is calculated by your Nexus® meter.

Time Stamp: A stored representation of the time of an event. Time Stamp can include year, month, day, hour, minute, second and Daylight Savings Time indication.

TOU: Time of Use.

Uncompensated Power:	VA, Watt and VAR readings not adjusted by Transformer Loss Compensation.
V2T Threshold:	Data will stop accumulating when voltage falls below programmed level.
Voltage Imbalance:	The ratio of the voltage on a phase to the average voltage on all phases.
Voltage Quality Event:	An instance of abnormal voltage on a phase. The events the meter tracks include sags, swells, interruptions and imbalances.
VT Ratio:	The Voltage Transformer Ratio is used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as PT Ratio.
Voltage, Vab:	Vab, Vbc, Vca are all Phase-to-Phase voltage measurements. These voltages are measured between the three phase voltage inputs to the meter.
Voltage, Van:	Van, Vbn, Vcn are all Phase-to-Neutral voltages applied to the monitor. These voltages are measured between the phase voltage inputs and Vn input to the meter. Technologically, these voltages can be "measured" even when the meter is in a Delta configuration and there is no connection to the Vn input. However, in this configuration, these voltages have limited meaning and are typically not reported.

Voltage, Vaux	This is the fourth voltage input measured from between the Vaux and Vref inputs. This input can be scaled to any value. However, the actual input voltage to the meter should be of the same magnitude as the voltages applied to the Va, Vb and Vc terminals.